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Cover Photograph: Black-necked Stork *Ephippiorhynchus asiaticus* by Asad R. Rahmani

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We are grateful to the Ministry of Science and Technology,
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Editorial

Reaching 100 years, whether in human life or an institute's life, is a reason for celebration. The Bombay Natural History Society celebrated 100 years of existence in 1983 with some memorable functions and presentations. Another milestone in the history of BNHS was reached in 2003 when the *Journal of the Bombay Natural History Society* completed 100 volumes. There are not many journals in the world, certainly not many in India, which have survived 100 years.

The *Journal* was started in 1886 with E.H. Aitken and R.A. Sterndale as the first editors. From Vol. 3, H.M. Phipson started editing the *Journal*. From the records available to us, 23 people have served as editors of the *Journal*, sometimes alone but generally in various combinations. Stalwarts like W.S. Millard, N.B. Kinnear, S.H. Prater, Sálim Ali, P.M. Sanderson, H. Santapau, H. Abdulali and J.C. Daniel have been editors of this prestigious *Journal*. Interestingly, among all the editors, Mr. Daniel had the longest innings, 40 years! His name first appeared in Vol. 62, 1965. Earlier, there used to be four issues per volume, and four issues of a particular volume were not necessarily published in a calendar year. Therefore, although the *Journal* was started in 1886, it completed 100 volumes in 2003. From Vol. 55, 1958, three issues per calendar year were published. We intend to continue this practice.

We have a distinguished list of names on our editorial board, each expert in his or her own field, some with more than 20 years of field research, and writing experiences. As we publish articles on all aspects of natural history, including new descriptions, we need a large editorial board that can peer-review the papers. From this volume, we have also added a team of consultant editors for further editorial inputs. Besides the editorial team and consultant editors, we also have a list of experts whom we will consult from time to time for peer-reviewing manuscripts. We intend to publish their names in the third issue of each volume. Our main purpose at the end of the day is to publish good scientific papers, and quickly.

One of the complaints, and a genuine one for that matter, is that the *Journal* takes very long to publish an accepted paper. I think it is a sort of compliment to us. We receive many good papers and it is difficult to reject them, and secondly, due to the prestige of the *Journal*, many contributors are willing to wait for 2-3 years to see their papers in *JBNHS* rather than elsewhere. However, at the same time, the long publication time discourages many talented young scientists who do not send papers to us. In order to reduce this time lag, we have requested our editorial board to be very selective in accepting a paper. We are also planning to increase the size of the next couple of issues to clear up our pending papers, and from next year, our aim is to see that an accepted paper is published within 12 months after its acceptance.

We have also decided to place abstracts of major papers on our website: www.bnhs.org. We are also planning on-line publishing, but this will be done only when we are sure that we will not lose *Journal* subscribers.

Presently, members have to pay only Rs. 150/- for the subscription of the *Journal*. Looking at the quality of the *Journal*, and increase in the publication cost and postal rates, I am sure subscribers would be happy to pay a higher subscription. We will inform you when the Society takes the decision to raise the subscription to the *Journal*.

The abbreviation of a journal becomes its brand name, to be quoted in scientific papers. *JBNHS* is a well-known acronym all over the world. Although there is the Bahrain Natural History Society, also called BNHS, I do not know whether they also publish a journal called 'JBNHS'. I hope not. I am still unable to understand how *Natural* in *J. Bombay nat. Hist. Soc.* came to be written in lower case. Nonetheless, from Vol. 101, it will be written in upper and lower cases, and the abbreviation will be *J. Bombay Nat. Hist. Soc.*

ASAD R. RAHMANI

BIRDS OF KAWAL WILDLIFE SANCTUARY, ANDHRA PRADESH, INDIA[1]

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Being a part of a large and contiguous forest tract in the Deccan Plateau, the Kawal Wildlife Sanctuary is an important Protected Area with high avian diversity. Altogether, 294 species belonging to 53 families were recorded during a two-year period between 1997 and 1999. Historical comparisons have also been drawn, and some species that were not recorded during this survey are discussed. The status of the Black-shouldered Woodpecker, Spotted Creeper and Little Spiderhunter is also discussed. It is proposed that further surveys in adjacent areas will yield interesting results and will be of considerable importance in recognizing this region as an Important Bird Area in Andhra Pradesh.

Key words: Kawal Wildlife Sanctuary, Adilabad district, avifauna, Andhra Pradesh

INTRODUCTION

Kawal Wildlife Sanctuary is one of the oldest and faunistically most diverse Protected Areas in Andhra Pradesh. The first documentation of avian diversity from the Utnoor Forest was done in 1930-31 by Sálim Ali during the Hyderabad State Ornithological Survey (Ali and Whistler 1933a, b, c; 1934a, b). In early 1978, a party of the Zoological Survey of India collected birds from four different sites in Adilabad district, of which three, namely Birsaipet, Itikyal, and Kadam are within the Kawal Wildlife Sanctuary (Majumdar 1984). Although the Forest Department staff and some members of the Birdwatchers' Society of Andhra Pradesh have documented birds from this region, the lack of a comprehensive checklist is quite evident. Keeping this in view, I maintained a record of bird sightings during field trips carried out while studying wild cervids for my doctoral research. This paper presents the first detailed systematic account of the avian diversity of Kawal Wildlife Sanctuary.

STUDY AREA

Established in 1965, Kawal Wildlife Sanctuary (19° 05'-19° 20' N and 78° 32'-79° 12' E) covers an area of 893 sq. km, making it one of the largest and oldest gazetted wildlife sanctuaries in Andhra Pradesh. Located in Adilabad district, it is situated 45 km from Mancherial, 70 km from Nirmal and 260 km from Hyderabad. The general topography of the area is undulating, with hills on the northern boundary and a gentle slope towards the Godavari river flowing 6-12 km from the southern boundary of the Sanctuary (Fig. 1).

The major peaks are Mamidepalligutta (664 m), Mysemgutta (553 m) and Thattlakonda (443 m). Very few waterbodies dot the area, the major ones being restricted to the northern region of the Sanctuary between Birsaipet and Utnoor. On the southern side, the Kadam Reservoir and the associated canal network forms the lifeline of the Sanctuary. There are a number of large and small shallow waterbodies along the southern boundary, though not strictly within the Sanctuary limits. A few seasonal streams also crisscross the Sanctuary.

The forest is of Southern Tropical Dry Deciduous type with *Tectona grandis*, *Terminalia tomentosa*, *Terminalia arjuna*, *Anogeissus latifolia*, *Boswellia serrata*, *Cleisanthus collinus*, *Lannea coromandelica*, *Diospyros melanoxylon* and *Bombax ceiba*, being predominant (Champion and Seth 1968). Patches of natural clumps of bamboo *Dendrocalamus strictus* are also found in the Sanctuary. Three reserve forests, namely Itikyal, Kadam and Kawal falling under Nirmal and Janaram Forest Divisions comprise the Sanctuary. The major vegetation compositions in these reserve forests are teak mixed miscellaneous forest and teak mixed bamboo forest. Teak mixed bamboo forest is more dominant (55%) than the teak mixed miscellaneous forest (40%) while the remaining areas are teak plantations, scrub areas or village enclosures. A road connecting Mancherial with Nirmal and Adilabad divides the Sanctuary into three zones. Cultivated areas and human habitation are found in the villages named in the Methodology section, in and around the Sanctuary.

METHODOLOGY

Regular monthly surveys following the imaginary grid method and line transect method by Gaston (1973) were carried out from March 1997 to March 1999, and bird records were maintained for the following selected areas of the Sanctuary: Utnoor, Birsaipet, Rampur, Udhumpur, Laxmipur, Dosthnagar, Kadam, Itikyal,

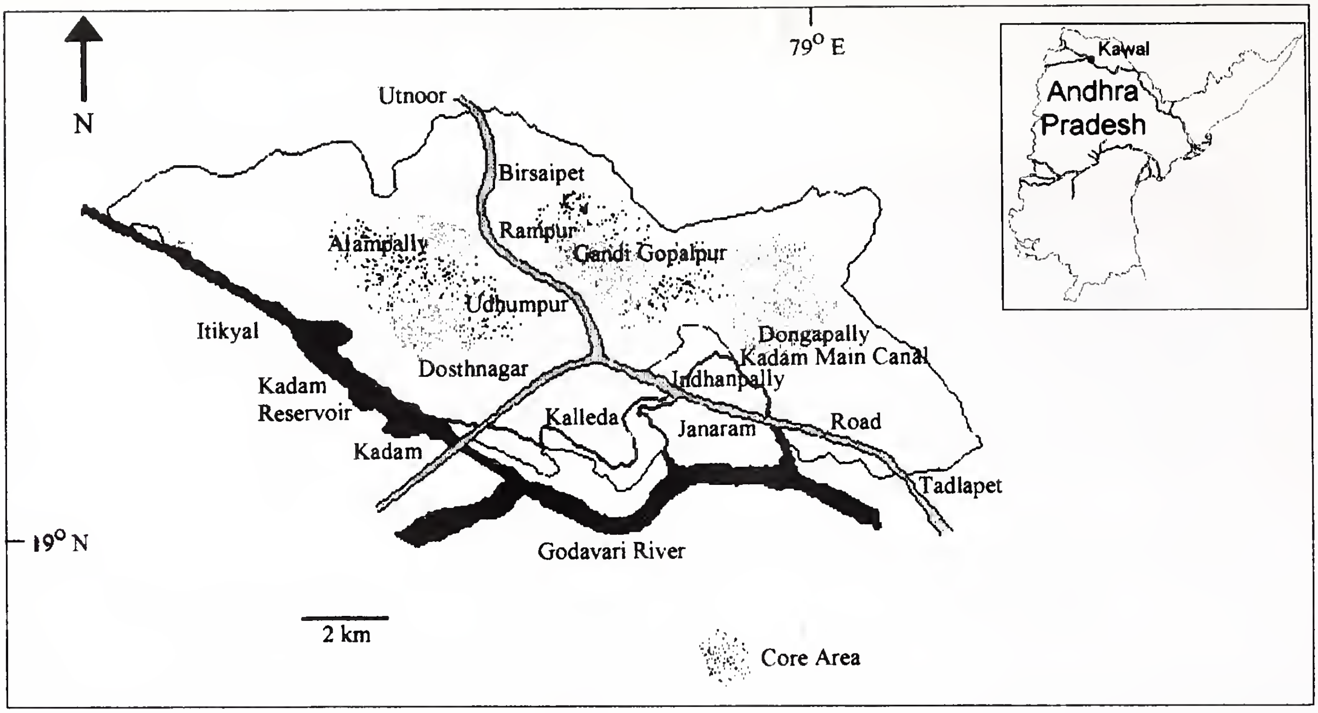

Fig. 1: Map of Kawal Wildlife Sanctuary, Andhra Pradesh

Kalleda, Narlapur, Indhanpally, Janaram, Kawal, Alinagar, Dongapally, Tapalapur and Tadlapet. Forested tracts within a radius of 2 to 8 km from these areas were selected for observations. Identification was based on Ali and Ripley (1983) and Ali (1996). Based on the number of sightings and occurrence, the status of a given species was assigned as common (encountered daily in relatively large numbers), uncommon (encountered daily but in small numbers) and rare (encountered less than 15 times a year).

RESULTS AND DISCUSSION

A total of 294 species belonging to 185 genera, 53 families and 17 orders were recorded (Table 1). Of these 49% (144 species) are common, 33% (98 species) are uncommon and 18% (52 species) are rare. Of these 45% (133 species) are resident breeders, 17% (49 species) are residents that possibly breed within the Sanctuary, 17% (49 species) are winter migrants, 8% (23 species) are seasonal or local migrants, 12% (36 species) are rare, while the rest are stragglers (4 species contributing 1%). Significant sight records were Jerdon's Baza (*Aviceda jerdoni*), Great Black Woodpecker (*Dryocopus javensis*), Spotted Creeper (*Salpornis spilonotus*) and Little Spiderhunter (*Arachnothera longirostra*).

Among the common species, 75% (108 species) are resident breeders, 3% (5 species) probably breed within the Sanctuary, 3% (4 species) are resident with no breeding records, 12% (17 species) are winter migrants, 6% (9 species) are probably residents or local migrants, and 0.69% (1 species) of undetermined resident status. Of the uncommon species, 28% (27 species) are resident breeders, 21% (21 species) are those that probably breed, 9% (9 species) are resident with no breeding records, 26% (26 species) are winter migrants, and 15% (15 species) are either seasonal or local migrants. Among the rare species, 56% (29 species) are of undetermined rare status, 17% (9 species) winter migrants, 6% (3 species) either seasonal or local migrants, 10% (5 species) stragglers, 1.0% (5 species) probable resident breeders, and one species (2%) that is, Black-shouldered Woodpecker (*Chrysocolaptes festivus*) is a rare resident breeder.

In the annotated checklist that follows, systematic listing is based on the Synopsis (Ripley 1982) and the common and scientific names follow Manakadan and Pittie (2001).

1. Little Grebe *Tachybaptus ruficollis* (Pallas)

Common. Resident breeder. Affects shallow waterbodies near human settlements and near Kadam Reservoir. Ali and Whistler (1934b) recorded this species from Utnoor.

2. Great Cormorant *Phalacrocorax carbo* (Linné)

Rare. Two records near Kadam Reservoir.

Table 1: Avian diversity of Kawal Wildlife Sanctuary, Adilabad district, Andhra Pradesh

Order	Family	No. of Genera	No. of Species
Podicipediformes	Podicipedidae	1	1
Pelecaniformes	Phalacrocoracidae	1	3
Ciconiiformes	Ardeidae	8	10
	Ciconiidae	3	3
	Threskiornithidae	4	4
Anseriformes	Anatidae	9	17
Falconiformes	Accipitiridae	18	27
	Falconidae	1	4
Galliformes	Phasianidae	6	12
Gruiformes	Turnicidae	1	3
	Rallidae	6	6
Charadriiformes	Jacanidae	2	2
	Charadriidae	9	17
	Rostratulidae	1	1
	Recurvirostridae	1	1
	Burhinidae	2	2
	Glareolidae	2	2
	Laridae	3	4
Columbiformes	Pteroclididae	1	2
	Columbidae	4	8
Psittaciformes	Psittacidae	1	3
Cuculiformes	Cuculidae	8	9
Strigiformes	Strigidae	8	8
Caprimulgiformes	Caprimulgidae	1	3
Apodiformes	Apodidae	4	4
Coraciiformes	Alcedinidae	3	3
	Meropidae	1	3
	Coraciidae	1	1
	Upupidae	1	1
	Bucerotidae	1	1
Piciformes	Capitonidae	1	2
	Picidae	7	8
Passeriformes	Pittidae	1	1
	Alaudidae	6	8
	Hirundinidae	1	5
	Laniidae	1	4
	Oriolidae	1	3
	Dicruridae	1	4
	Artamidae	1	1
	Sturnidae	2	7
	Corvidae	2	3
	Campephagidae	3	6
	Irenidae	2	3
	Pycnonotidae	1	3
	Muscicapidae	27	42
	Paridae	1	2
	Sittidae	2	3
	Motacillidae	3	8
	Dicaeidae	1	2
	Nectariniidae	2	3
	Zosteropidae	1	1
	Ploceidae	3	4
	Estrildidae	2	5
	Fringillidae	1	1

3. **Indian Shag** ***Phalacrocorax fuscicollis*** **Stephens**

Rare. Recorded twice during the study period. Once each from the vicinity of Kadam Reservoir and Indhanpally Tank.

4. **Little Cormorant** ***Phalacrocorax niger*** **(Vieillot)**

Common. Recorded in fair numbers near Kadam Reservoir and its associated canal network, and also from smaller pools inside the Sanctuary. Breeding not recorded.

5. **Grey Heron** ***Ardea cinerea*** **Linné**

Uncommon. Probably a resident, though breeding not recorded within the Sanctuary. Regularly seen along the shallow waterbodies between Janaram and Kadam. Ali and Whistler (1934b) recorded this species from Utnoor.

6. **Purple Heron** ***Ardea purpurea*** **Linné**

Uncommon. Probably a resident, though breeding not recorded within the Sanctuary. A few individuals regularly recorded along the shallow waterbodies between Indhanpally and Kadam. Sálim Ali collected a female specimen from Utnoor (Ali and Whistler 1934b).

7. **Large Egret** ***Casmerodius albus*** **(Linné)**

Uncommon. Affects shallow waterbodies between Indhanpally and Kadam, and to a lesser extent those between Janaram and Tadlapet. Totally absent from July to September-October. Breeding not recorded from or around the Sanctuary.

8. **Indian Pond-heron** ***Ardeola grayii*** **(Sykes)**

Common. Resident breeder. Affects water edges, paddy fields, small streams and canals inside the Sanctuary. Breeding colonies recorded in the groves on fringe villages of Janaram, Indhanpally, Kadam, Utnoor, and Itikyal. Shares nesting trees with Little Egret and Cattle Egret. Ali and Whistler (1934b) recorded it from Utnoor. Majumdar (1984) found it to be common and collected a male from Kadam.

9. **Cattle Egret** ***Bubulcus ibis*** **(Linné)**

Common. Resident breeder. Large numbers affect the agro-ecosystem along the fringe villages. Seen following livestock that graze within the Sanctuary. Locals report that it follows the Indian Gaur (*Bos gaur* too. Breeding colonies recorded in the groves of fringe villages of Janaram, Indhanpally, Kadam, Utnoor, and Tadlapet. Ali and Whistler (1934b) recorded this species from Utnoor.

10. **Median Egret *Mesophoyx intermedia* (Wagler)**

Common. Seen along with the Little Egret affecting waterbodies between Indhanpally and Kadam. Probably a local migrant, observed in good numbers between September and February, up to March.

11. **Little Egret *Egretta garzetta* (Linné)**

Common. Resident breeder. As numerous as Cattle Egret. Affects all waterbodies near human settlements as well as in forested tracts. Breeding colonies recorded in the groves of fringe villages of Janaram, Indhanpally, Kadam, Utnoor, Tadlapet, Itikyal and Birsaipet.

12. **Black-crowned Night-heron**
***Nycticorax nycticorax* (Linné)**

Uncommon. Very few individuals have been recorded in waterbodies along the Kadam Reservoir and associated canals. Although breeding was not recorded within the Sanctuary, subadult birds were regularly encountered. Ali and Whistler (1934b) recorded this species from Utnoor.

13. **Chestnut Bittern**
***Ixobrychus cinnamomeus* (Gmelin)**

Rare. Recorded thrice in the vegetation on the southwestern edge of Kadam Reservoir.

14. **Yellow Bittern *Ixobrychus sinensis* (Gmelin)**

Uncommon. Infrequently observed near Kadam Reservoir and large shallow waterbodies along the southern boundary of the Sanctuary. Breeding not observed.

15. **Painted Stork *Mycteria leucocephala* (Pennant)**

Uncommon. About 4-10 birds observed feeding busily in Indhanpally Tank between July and September. Sightings of juvenile individuals may indicate the presence of a breeding colony within 150-200 km radius of the Sanctuary.

16. **Asian Openbill-Stork *Anastomus oscitans* (Boddaert)**

Common. Regularly seen in large numbers (up to 70-80 individuals) in Indhanpally Tank. No breeding records within the Sanctuary, although juveniles were regularly sighted, indicating the presence of a breeding colony nearby. Majumdar (1984) collected a female from Kadam.

17. **White-necked Stork**
***Ciconia episcopus* (Boddaert)**

Uncommon. Five records along the Kadam river downstream from Kadam Dam, other than a pair that was regularly observed in teak plantations between Indhanpally, Narlapur and Kalleda from October to February.

18. **Oriental White Ibis**
***Threskiornis melanocephalus* (Latham)**

Uncommon. Recorded between July and September along large shallow waterbodies between Indhanpally and Kadam.

19. **Black Ibis *Pseudibis papillosa* (Temminck)**

Common. Regularly recorded in good numbers in paddy fields along the southern boundary of the Sanctuary, and also between Birsaipet and Utnoor. No breeding colony was recorded within or along the boundary of the Sanctuary.

20. **Glossy Ibis *Plegadis falcinellus* (Linné)**

Rare. Two records (3 and 8 individuals each), between Indhanpally and Kadam.

21. **Eurasian Spoonbill *Platalea leucorodia* Linné**

Uncommon. Recorded from September to February along large shallow waterbodies between Indhanpally and Kadam.

22. **Bar-headed Goose *Anser indicus* (Latham)**

Rare. Two records on the edge of the Kadam Reservoir.

23. **Lesser Whistling-duck**
***Dendrocygna javanica* (Horsfield)**

Common and resident. Affects all shallow waterbodies along the southern boundary of the Sanctuary, and has also been recorded from small rainwater inundated pools within the forest. Although no nests were recorded, it probably breeds within the Sanctuary. Ali and Whistler (1934b) report its occurrence in Utnoor. Majumdar (1984) found it to be not very common and collected two females from Birsaipet.

24. **Large Whistling-duck**
***Dendrocygna bicolor* (Vieillot)**

Rare. Recorded once (6 individuals) in November 1998 from Indhanpally Tank.

25. **Brahminy Shelduck *Tadorna ferruginea* (Pallas)**

Uncommon. Migratory. 2 to 6 individuals from Kadam river downstream from Kadam Dam. Majumdar (1984) collected a pair of these birds from Kadam.

26. **Northern Pintail *Anas acuta* Linné**

Common. Migratory. About 15 individuals regularly recorded affecting large shallow waterbodies along the southern boundary of the Sanctuary.

27. **Common Teal** ***Anas crecca*** **Linné**

Common. Migratory. About 10 individuals recorded during winters of 1997 and 1999 in the Indhanpally Tank.

28. **Spot-billed Duck**
Anas poecilorhyncha **J. R. Forester**

Common. Resident breeder. Over 20 individuals regularly recorded affecting large shallow waterbodies along the southern boundary of the Sanctuary. Regularly recorded breeding in a tank just outside Janaram and also at Indhanpally Tank. Majumdar (1984) found it to be common and collected a male specimen from Kadam.

29. **Gadwall** ***Anas strepera*** **Linné**

Rare. Migratory. Recorded once (2 individuals) from the Indhanpally Tank during November 1997.

30. **Eurasian Wigeon** ***Anas penelope*** **Linné**

Rare. Migratory. Recorded twice (one and two individuals, respectively) from the Indhanpally Tank during November 1997.

31. **Garganey** ***Anas querquedula*** **Linné**

Common. Migratory. Over 20 individuals regularly recorded affecting the large shallow waterbodies along the southern boundary of the Sanctuary and also between Rampur and Utnoor. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) reported it to be very common near Birsaipet where he collected two male and three female specimens.

32. **Northern Shoveller** ***Anas clypeata*** **Linné**

Uncommon. Migratory. Recorded throughout the winter of 1998-99 ranging from 3-18 individuals at Indhanpally Tank. Sálim Ali mentions having observed it on 15.x.1924 at Utnoor (Ali and Whistler 1934b).

33. **Red-crested Pochard**
Rhodonessa rufina **(Pallas)**

Uncommon. Migratory. Recorded throughout the winter of 1997-98 and 1998-99, ranging from 2-6 individuals at Indhanpally Tank.

34. **Common Pochard** ***Aythya ferina*** **(Linné)**

Rare. Migratory. Recorded once (a pair) in December 1998 at Indhanpally Tank.

35. **Ferruginous Pochard**
Aythya nyroca **(Güldenstädt)**

Rare. Migratory. Recorded once (a pair) in November 1998 at Indhanpally Tank.

36. **Tufted Pochard** ***Aythya fuligula*** **(Linné)**

Rare. Migratory. Recorded once (5 individuals) in December 1998 at Indhanpally Tank.

37. **Cotton Teal** ***Nettapus coromandelianus*** **(Gmelin)**

Common. Local migrant. Observed (at least a pair) in all large shallow waterbodies of the Sanctuary. Maximum number recorded at any given time were 27 individuals. Ali and Whistler (1934b) recorded this species from Utnoor.

38. **Comb Duck** ***Sarkidiornis melanotos*** **(Pennant)**

Uncommon. Local migrant. Regularly recorded from 2 to 28 individuals in all the study years at Indhanpally Tank. Ali and Whistler (1934b) recorded this species from Utnoor.

39. **Black-shouldered Kite**
Elanus caeruleus **(Desfontaines)**

Common. Resident breeder. Affects open patches of the forest and also along the agricultural lands of the fringe villages. Majumdar (1984) found it to be very common and collected a male, a female and two female specimens from Kadam, Itikyal, and Birsaipet respectively.

40. **Jerdon's Baza** ***Aviceda jerdoni*** **(Blyth)**

Rare. Once sighted near Alinagar exclosure in the core area of the Sanctuary.

41. **Oriental Honey-buzzard**
Pernis ptilorhynchus **(Temminck)**

Uncommon. Affects open forest patches. Number of sightings less in summer and monsoon than in winter when it was frequently observed. No records of breeding within the Sanctuary.

42. **Black Kite** ***Milvus migrans*** **(Boddaert)**

Common. Resident breeder. Recorded in good numbers, and nests were recorded in the vicinity of human settlements.

43. **Brahminy Kite** ***Haliastur indus*** **(Boddaert)**

Common. Resident breeder. Restricted in distribution to Kadam Reservoir area. Occasionally also recorded along the canal and natural streams criss-crossing the Sanctuary. Nests were observed near the Reservoir area and young were recorded from July-August onwards. Ali and Whistler (1934b) recorded this species from Utnoor.

44. **Shikra *Accipiter badius* (Gmelin)**

Common. Resident breeder. Affects open wooded areas of the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be common in certain areas and collected a male specimen from Itikyal, and a pair from Kadam.

45. **Crested Goshawk**
***Accipiter trivirgatus* (Temminck)**

Rare. Twice sighted in teak mixed bamboo forest near Rampur during winter of 1998.

46. **Besra Sparrow-hawk**
***Accipiter virgatus* (Temminck)**

Rare. One bird sighted near Kalleda in November 1998.

47. **Long-legged Buzzard**
***Buteo rufinus* (Cretzschmar)**

Rare. One bird sighted in December 1997 near the teak plantation area adjacent to Laxmipur exclosure.

48. **White-eyed Buzzard**
***Butastur teesa* (Franklin)**

Rare. Once sighted in February 1999 near Nalakonda, Shivar Pedda Vagu area. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be common near Itikyal and collected 3 male specimens from the same area.

49. **Changeable Hawk-eagle**
***Spizaetus cirrhatus* (Gmelin)**

Common. Frequently seen along the gaps created by roads criss-crossing the Sanctuary. Although no nests were sighted it presumably breeds within the Sanctuary, as it is seen all year round. Majumdar (1984) found it to be common near Birsaipet, where he collected a female specimen.

50. **Tawny Eagle *Aquila rapax* Temminck**

Common. Seen in good numbers throughout the Sanctuary. No breeding was recorded.

51. **Greater Spotted Eagle *Aquila clanga* Pallas**

Rare. Once sighted near the southern edge of the Kadam Reservoir in January 1999.

52. **Lesser Spotted Eagle *Aquila pomarina* Brehm**

Rare. Two sightings, first near northern edge of the Dam on the Kadam Reservoir in November 1998, and another along the main canal of Kadam Reservoir in January 1999.

53. **Black Eagle *Ictinaetus malayensis* (Temminck)**

Rare. Once sighted near Kalleda Vagu (Pedda Vagu) in May 1998.

54. **Red-headed Vulture *Sarcogyps calvus* (Scopoli)**

Rare. Six individuals sighted feeding on carcass of cow along with other vulture species on the edge of Kadam Reservoir in January 1998.

55. **Eurasian Griffon *Gyps fulvus* (Hablizl)**

Uncommon. Twenty-one individuals have been recorded in 3 sightings on the edges of Kadam Reservoir. Ali and Whistler (1934b) recorded this species from Utnoor.

56. **Long-billed Vulture *Gyps indicus* (Scopoli)**

Uncommon. Thirty-eight individuals have been recorded in 3 sightings on the edge of Kadam Reservoir and one near Tadlapet. Ali and Whistler (1934b) recorded this species from Utnoor.

57. **Indian White-backed Vulture *Gyps bengalensis* (Gmelin)**

Uncommon. Not frequently seen, probable resident. Thirty-two to forty birds have been recorded in a total of seven sightings all along the fringes of the Sanctuary. No sightings since August 1999. Ali and Whistler (1934b) recorded this species from Utnoor.

58. **Egyptian Vulture**
***Neophron percnopterus* (Linné)**

Uncommon. A pair was frequently seen near Kadam Reservoir area till August 1999.

59. **Pallid Harrier**
***Circus macrourus* (S. G. Gmelin)**

Uncommon. Regularly seen affecting open forests and agriculture fields.

60. **Montagu's Harrier *Circus pygargus* (Linné)**

Rare. Pair seen in January 1999, near a check-dam near Udhumpur.

61. **Pied Harrier *Circus melanoleucos* (Pennant)**

Uncommon. Regularly seen along agriculture fields downstream of Kadam Dam and twice sighted in the open valley near Rampur.

62. **Western Marsh-harrier**
***Circus aeruginosus* (Linné)**

Rare. Recorded twice in the agriculture fields downstream of the Kadam Dam during the winter of 1998-99.

63. **Short-toed Snake-eagle *Circaetus gallicus* (Gmelin)**

Common. Regularly seen affecting open forests and also cultivated fields. Probably a breeder, though no nests were recorded.

64. **Crested Serpent-eagle *Spilornis cheela* (Latham)**

Common. Seen in fairly good numbers affecting teak plantations and natural teak mixed miscellaneous forests. Although no nests were recorded, it probably breeds within the Sanctuary. Majumdar (1984) reported it to be widely distributed and collected a female specimen from Birsaipet.

65. **Osprey *Pandion haliaetus* (Linné)**

Rare. Recorded twice (December 1997 and February 1998) fishing on the Kadam Reservoir.

66. **Laggar *Falco jugger* J. E. Gray**

Rare. Once sighted near the village enclosure of Laxmipur.

67. **Peregrine Falcon *Falco peregrinus* Tunstall**

Rare. Three records during winter in the vicinity of Kadam Reservoir.

68. **Red-headed Falcon *Falco chicquera* Daudin**

Common. Regularly seen affecting open forests and cultivated fields, especially along the village enclosures between Indhanpally and Kadam on the southern boundary, and Birsaipet and Utnoor on the northern side of the Sanctuary. Breeding not recorded.

69. **Common Kestrel *Falco tinnunculus* Linné**

Common. Regularly seen affecting open forests, teak plantations and village enclosures within the Sanctuary. Majumdar (1984) reported it to be rare and collected a female specimen from Itikyal.

70. **Painted Francolin *Francolinus pictus* (Jardine & Selby)**

Common. Resident breeder. Recorded along the scrub and forest edge mainly near Birsaipet, Kalleda and Itikyal. Ali and Whistler (1934b) recorded this species from Utnoor.

71. **Grey Francolin *Francolinus pondicerianus* (Gmelin)**

Common. Resident breeder. Recorded along the scrub, agriculture fields and forest edge throughout the Sanctuary. Ali and Whistler (1934b) reported this species to be absent from Utnoor.

72. **Common Quail *Coturnix coturnix* (Linné)**

Common. Resident breeder. Recorded along the scrub, agriculture fields and forest edge throughout the Sanctuary.

73. **Rain Quail *Coturnix coromandelica* (Gmelin)**

Common. Resident breeder. Recorded to affect scrub, fallow and cultivated fields, and forest edge especially along the human settlements throughout the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor.

74. **Blue-breasted Quail *Coturnix chinensis* (Linné)**

Uncommon. Resident breeder. Recorded in small numbers affecting fallow and scrubland throughout the fringe areas of the Sanctuary.

75. **Jungle Bush-quail *Perdicula asiatica* (Latham)**

Common. Resident breeder. Recorded in good numbers along the open scrub, agriculture fields and in the rocky habitat in the vicinity of village enclosures. Sálim Ali collected a couple of male specimens from Utnoor (Ali and Whistler 1934b). Majumdar (1984) collected a male specimen from Itikyal.

76. **Rock Bush-quail *Perdicula argoondah* (Sykes)**

Uncommon. Resident breeder. Recorded in small numbers along the northern areas of the Sanctuary.

77. **Red Spurfowl *Galloperdix spadicea* (Gmelin)**

Common. Resident breeder. Females on nests were observed in teak mixed bamboo forest patches between January and March. Fairly well represented throughout the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor.

78. **Painted Spurfowl *Galloperdix lunulata* (Valenciennes)**

Uncommon. Resident breeder. Frequently met with in teak mixed miscellaneous and teak mixed bamboo forest patches within the Sanctuary.

79. **Red Junglefowl *Gallus gallus* (Linné)**

Uncommon. Resident breeder. A few individuals noted in teak mixed miscellaneous forests near Dongapally, Rampur and Alampally areas.

80. **Grey Junglefowl *Gallus sonneratii* (Temminck)**

Common. Resident breeder. Found in good numbers throughout the undisturbed or less disturbed areas of the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor.

81. **Indian Peafowl** ***Pavo cristatus*** **Linné**

Common. Resident breeder. Fairly good numbers throughout the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor.

82. **Small Buttonquail** ***Turnix sylvatica*** **(Desfontaines)**

Rare. Twice sighted between Birsaipet and Utnoor. Probably a resident breeder.

83. **Yellow-legged Buttonquail** ***Turnix tanki*** **Blyth**

Uncommon. Occasional sightings along agriculture fields and scrub openings. It probably breeds within the Sanctuary.

84. **Common Buttonquail** ***Turnix suscitator*** **(Gmelin)**

Uncommon. Occasionally sighted in a few localities between Rampur and Utnoor, and between Indhanpally and Kadam. It probably breeds within the Sanctuary. Majumdar (1984) reported it to be not very common and collected a female specimen from Birsaipet.

85. **Spotted Crake** ***Porzana fusca*** **(Linné)**

Rare. Once sighted near Kadam Reservoir. Probably a straggler or has been overlooked due to its secretive nature.

86. **White-breasted Waterhen**
Amaurornis phoenicurus **(Pennant)**

Common. Resident breeder. Affects stream beds, canals, shallow waterbodies, and the vicinity of the Kadam Reservoir.

87. **Watercock** ***Gallicrex cinerea*** **(Gmelin)**

Common. Resident breeder but recorded in small numbers. Observed from Kadam Reservoir and its adjoining area, from all shallow waterbodies scattered along the southern boundary, and from a seasonal stream between Birsaipet and Utnoor.

88. **Common Moorhen** ***Gallinula chloropus*** **(Linné)**

Common. Resident breeder. Recorded in moderate numbers all through the year in large shallow waterbodies along the southern boundary. Numbers increase during the winter season. Ali and Whistler (1934b) recorded this species from Utnoor.

89. **Purple Moorhen** ***Porphyrio porphyrio*** **(Linné)**

Common. Resident breeder. Fewer in number than the Common Moorhen. Recorded from all shallow waterbodies scattered along the southern boundary. Numbers increase during the winter season. Ali and Whistler (1934b) reported this species as not uncommon in Utnoor.

90. **Common Coot** ***Fulica atra*** **Linné**

Common. Resident breeder. A few individuals have been recorded throughout the year from large shallow waterbodies and Kadam Reservoir. Populations increase considerably during winter. Majumdar (1984) found it to be common and collected a male specimen from Birsaipet.

91. **Pheasant-tailed Jacana**
Hydrophasianus chirurgus **(Scopoli)**

Uncommon within the Sanctuary limits, but a common resident breeder recorded in good numbers from the smaller shallow waterbodies scattered between Indhanpally and Kadam. Ali and Whistler (1934b) recorded this species from Utnoor.

92. **Bronze-winged Jacana**
Metopidius indicus **(Latham)**

More common than the Pheasant-tailed Jacana. Resident breeder, very frequently seen on all the waterbodies within the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor.

93. **Greater Painted-snipe**
Rostratula benghalensis **(Linné)**

Rare. A single male was observed in February 1998 near Indhanpally tank. Ali and Whistler (1934b) recorded this species from Utnoor.

94. **Red-wattled Lapwing**
Vanellus indicus **(Boddaert)**

Common. Resident breeder. Frequently observed in scrub forest areas and adjacent village enclosures. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be very common and collected a female specimen from Itikyal.

95. **River Lapwing** ***Vanellus duvaucelii*** **(Lesson)**

Uncommon. Frequently observed along Kadam and its network of canals.

96. **Yellow-wattled Lapwing**
Vanellus malabaricus **(Boddaert)**

Common. Resident breeder. Affects open scrub forest and adjacent village enclosures. Ali and Whistler (1934b) recorded this species from Utnoor.

97. **Pacific Golden Plover**
Pluvialis fulva **(Gmelin)**

Rare. Once sighted (6 individuals) downstream of the Kadam Dam in December 1998. Probably stragglers. Ali and Whistler (1934b) reported it to be absent from Utnoor.

98. **Greater Sand Plover**
***Charadrius leschenaultii* Lesson**

Rare. Once seen in November 1998 near Indhanpally Tank. Probably a straggler.

99. **Little Ringed Plover *Charadrius dubius* Scopoli**

Common. Winter migrant. Recorded from all the waterbodies within the Sanctuary, more common along the Kadam and associated canals. Majumdar (1984) reported it to be not very common and collected a female specimen from Itikyal.

100. **Kentish Plover *Charadrius alexandrinus* Linné**

Uncommon. Winter migrant. Infrequently recorded from large shallow waterbodies along the southern boundary of the Sanctuary. Majumdar (1984) collected a pair from Kadam.

101. **Eurasian Curlew *Numenius arquata* (Linné)**

Rare. One pair sighted in flight near Kadam Reservoir in December 1998. Probably stragglers.

102. **Black-tailed Godwit *Limosa limosa* (Linné)**

Rare. Two individuals sighted near paddy fields near the Kadam Reservoir in November 1998. No sightings within the Sanctuary limits.

103. **Common Redshank *Tringa totanus* (Linné)**

Common. Winter migrant. Seen along all larger shallow waterbodies within the Sanctuary.

104. **Marsh Sandpiper**
***Tringa stagnatilis* (Bechstein)**

Common. Winter migrant. Seen along larger shallow waterbodies near Tadlapet, Indhanpally to Kadam, and Utnoor.

105. **Common Greenshank**
***Tringa nebularia* (Gunner)**

Uncommon. Winter migrant. Seen in small numbers along shallow waterbodies between Kadam and Indhanpally. Majumdar (1984) collected one female specimen each from Itikyal and Birsaipet.

106. **Wood Sandpiper *Tringa glareola* Linné**

Common. Winter migrant. Seen along large shallow waterbodies between Kadam and Indhanpally. Ali and Whistler (1934b) recorded this species from Utnoor and its adjoining area.

107. **Common Sandpiper *Actitis hypoleucos* Linné**

Common. Winter migrant. Seen in fairly good numbers affecting all waterbodies within the Sanctuary.

108. **Common Snipe *Gallinago gallinago* (Linné)**

Uncommon. Winter migrant. Frequently observed in small numbers at Indhanpally Tank and Kadam Reservoir. Sálim Ali reports flushing a pair on April 8, 1932 among reeds bordering a tank at Utnoor (Ali and Whistler 1934b).

109. **Little Stint *Calidris minuta* (Leisler)**

Common. Regularly seen in fairly good numbers affecting large waterbodies within the Sanctuary. Along smaller waterbodies up to 12 individuals were observed.

110. **Temminck's Stint *Calidris temminckii* (Leisler)**

Common. Regularly seen in mixed flocks with little stint. Confined to large waterbodies. Very few individuals were sighted along smaller waterbodies.

111. **Black-winged Stilt**
***Himantopus himantopus* (Linné)**

Common. Winter migrant. Regularly recorded in flocks up to 76 individuals affecting large shallow waterbodies and paddy fields between Janaram and Kadam, and also in the vicinity of Utnoor. Ali and Whistler (1934b) did not record this species from Utnoor.

112. **Stone Curlew *Burhinus oedicnemus* (Linné)**

Uncommon. Resident breeder. Affects open scrub strewn with boulders. Young ones were observed between March and May.

113. **Great Stone-plover**
***Esacus recurvirostris* (Cuvier)**

Uncommon. One pair regularly noted along the Kadam river downstream of the Kadam Dam. Possibly breeds within the Sanctuary. Ali and Whistler (1934b) recorded this species from Utnoor and its environs.

114. **Indian Courser**
***Cursorius coromandelicus* (Gmelin)**

Uncommon. Regularly seen in small flocks up to six individuals affecting scrub areas of the Sanctuary.

115. **Small Pratincole**
***Glareola lactea* (Temminck)**

Rare. Twice recorded in flocks of 8 and 11 individuals in November 1998. Majumdar (1984) collected a pair of specimens from Kadam.

116. **Brown-headed Gull**
***Larus brunnicephalus* Jerdon**

Rare. Thrice sighted between October and December 1998 near Kadam Reservoir.

117. **Whiskered Tern** ***Chlidonias hybridus*** **(Pallas)**

Uncommon. One to six individuals regularly sighted near Kadam Reservoir.

118. **River Tern** ***Sterna aurantia*** **J.E. Gray**

Common. Regularly sighted near Kadam Reservoir and all along the major canals in the Sanctuary.

119. **Little Tern** ***Sterna albifrons*** **Pallas**

Rare. Once sighted in March 1998 near Kadam Reservoir. Identified by its small size, black cap and orange bill.

120. **Chestnut-bellied Sandgrouse**
Pterocles exustus **Temminck**

Uncommon. A few individuals regularly sighted along the cultivated or fallow tracts of village enclosures within the Sanctuary. Probably a breeder within the Sanctuary.

121. **Painted Sandgrouse** ***Pterocles indicus*** **(Gmelin)**

Rare. Twice sighted in flight, identified by the lack of pin feathers. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be not very common and collected a pair from Itikyal.

122. **Orange-breasted Green-pigeon**
Treron bicincta **(Jerdon)**

Uncommon. Resident breeder. Regularly seen in small flocks affecting teak mixed miscellaneous forest and teak mixed bamboo forest patches between Rampur and Birsaipet. Majumdar (1984) reported it to be very common and collected two male specimens from Birsaipet.

123. **Yellow-legged Green-pigeon**
Treron phoenicoptera **(Latham)**

Uncommon. Resident breeder. Regularly seen in small flocks of 2 to 8 individuals affecting teak mixed miscellaneous forest patches. Majumdar (1984) found it to be common and collected a male and three female specimens from Kadam, and a female specimen from Birsaipet.

124. **Green Imperial-pigeon** ***Ducula aenea*** **(Linné)**

Uncommon. Resident breeder. Regularly seen in small flocks of 2 to 6 individuals all along the thick, forested tracts.

125. **Blue Rock Pigeon** ***Columba livia*** **Gmelin**

Common. Resident breeder. Regularly seen around villages and fallow fields. Nests observed in towns.

126. **Eurasian Collared-dove**
Streptopelia decaocto **(Frivaldszky)**

Common. Resident breeder. Ubiquitous in villages, cultivated and fallow fields. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be very common and collected a pair of specimens from Itikyal.

127. **Red Collared-dove**
Streptopelia tranquebarica **(Hermann)**

Common. Resident breeder. Regularly seen around villages and fallow fields. Sálim Ali reports sighting of this species from Nirmal in 1925 (Ali and Whistler 1934b).

128. **Spotted Dove** ***Streptopelia chinensis*** **(Scopoli)**

Common. Resident breeder. Regularly seen affecting cultivated or fallow fields, and around village enclosures. Ali and Whistler (1934b) recorded this species from Utnoor. Majumdar (1984) found it to be very common and collected a female specimen from Kadam.

129. **Little Brown Dove**
Streptopelia senegalensis **(Linné)**

Common. Resident breeder. Regularly seen near cultivated or fallow fields, open scrub and teak mixed miscellaneous forests. Majumdar (1984) reported it to be very common and collected a female specimen from Kadam.

130. **Alexandrine Parakeet**
Psittacula eupatria **(Linné)**

Uncommon. Resident breeder. Regularly observed in large flocks affecting jowar and maize crops especially areas between Rampur and Utnoor. Ali and Whistler (1934a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected a female specimen from Itikyal.

131. **Rose-ringed Parakeet**
Psittacula krameri **(Scopoli)**

Common. Resident breeder. Regularly seen in large flocks affecting jowar, bajra and maize crops grown in cultivated tracts of village enclosures. Up to 10,000 individuals roost in 5 ha teak plantation near Dosthnagar. Ali and Whistler (1934a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected two pairs of specimens from Itikyal.

132. **Plum-headed Parakeet**
Psittacula cyanocephala **(Linné)**

Uncommon. Resident breeder. Frequently sighted in good numbers affecting maize, jowar and bajra fields between Birsaipet and Utnoor, and near Tadlapet. Sálim Ali collected a male specimen from Utnoor environs (Ali and Whistler 1934a). Majumdar (1984) found it to be very common and collected three male and five female specimens from Itikyal, and two male specimens from Kadam.

133. **Pied Crested Cuckoo**
***Clamator jacobinus* (Boddaert)**

Common. Resident; although not noted, probably a breeder. Regularly seen throughout the year with augmentation in numbers between late May to October.

134. **Brainfever Bird *Hierococcyx varius* (Vahl)**

Common. Resident breeder. Seen throughout the year. One pair observed copulating in early March 1999. Probably a brood parasite on *Turdoides* sp. nests. Ali and Whistler (1934a) recorded this species from Utnoor. Majumdar (1984) collected one and two specimens (all male) from Birsaipet and Itikyal respectively.

135. **Common Cuckoo *Cuculus canorus* Linné**

Rare. Occasionally heard, but never sighted in summer.

136. **Indian Plaintive Cuckoo**
***Cacomantis passerinus* (Vahl)**

Uncommon. Resident, breeding not observed. Regularly seen in teak mixed miscellaneous forests.

137. **Drongo Cuckoo *Surniculus lugubris* (Horsfield)**

Rare. A single record from Kalleda Teak Plantation area in November 1998.

138. **Asian Koel *Eudynamys scolopacea* (Linné)**

Common. Resident breeder. Seen year-round throughout the Sanctuary, call more vociferous during the monsoon. Ali and Whistler (1934a) recorded this species from Utnoor.

139. **Small Green-billed Malkoha**
***Phaenicophaeus viridirostris* (Jerdon)**

Common. Resident breeder. Frequently sighted affecting mixed miscellaneous forest patches.

140. **Sirkeer Cuckoo**
***Phaenicophaeus leschenaultii* Lesson**

Uncommon. Resident breeder. Seen along the forest edges. Courtship observed between April and May. Ali and Whistler (1934a) recorded this species from Utnoor.

141. **Great Coucal *Centropus sinensis* (Stephens)**

Common. Resident breeder. Seen throughout the Sanctuary. Mating pairs were observed from August to September. Ali and Whistler (1934a) collected a male specimen from Utnoor.

142. **Barn Owl *Tyto alba* (Scopoli)**

Uncommon. Resident breeder. Infrequently seen in open patches around village enclosures. Sálim Ali reported sighting of this species at Talamadri village on October 14, 1925 (Ali and Whistler 1934a).

143. **Collared Scops-owl *Otus bakkamoena* Pennant**

Common. Resident breeder. Affecting both natural teak mixed miscellaneous forest and teak plantation areas. Ali and Whistler (1934a) did not record this species from Utnoor.

144. **Eurasian Eagle-owl *Bubo bubo* (Linné)**

Uncommon. Resident breeder. Frequently seen along rocky outcrops within the Sanctuary. Majumdar (1984) found it to be uncommon and collected a male specimen from Itikyal.

145. **Brown Fish-owl *Ketupa zeylonensis* (Temminck)**

Uncommon. Resident breeder. Regularly seen along well-wooded forest patches. Near Kadam Reservoir and associated canals. One nest was observed in a cavity of *Samanea saman* on the outskirts of Kadam village.

146. **Jungle Owlet *Glaucidium radiatum* (Tickell)**

Common. Resident breeder. Affects teak mixed miscellaneous forest patches and teak plantation areas. Sálim Ali collected an unsexed specimen from Utnoor (Ali and Whistler 1934a).

147. **Spotted Owlet *Athene brama* (Temminck)**

Common. Resident breeder. Frequently seen and heard in villages and scrub areas. Ali and Whistler (1934a) recorded this species from Utnoor. Majumdar (1984) found it to be very common and collected one female from Itikyal and two females from Kadam.

148. **Mottled Wood-owl *Strix ocellata* (Lesson)**

Uncommon. Resident breeder. Frequently seen in villages and scrub areas.

149. **Short-eared Owl *Asio flammeus* (Pontoppidan)**

Rare. Once recorded near Laxminagar hamlet in January 1999.

150. **Indian Jungle Nightjar**
***Caprimulgus indicus* Latham**

Common. Resident breeder. Regularly seen throughout the Sanctuary.

151. **Common Indian Nightjar**
***Caprimulgus asiaticus* Latham**

Common. Resident breeder. Frequently seen at night feeding over roads criss-crossing the Sanctuary. Majumdar (1984) found it to be very common and collected three males and one female from Itikyal, and a female from Birsaipet.

152. **Franklin's Nightjar**
***Caprimulgus affinis* Horsfield**

Uncommon. Very few sightings within the Sanctuary. Probably breeds within the Sanctuary. Sálim Ali collected a pair of specimens from Utnoor (Ali and Whistler 1934a).

153. **Alpine Swift *Tachymarptis melba* (Linné)**

Uncommon. Winter migrant. Flocks regularly seen from September to January.

154. **House Swift *Apus affinis* (J.E. Gray)**

Common. Resident breeder. Seen throughout the year, a large breeding colony recorded under the bridge across Kadam river below the Kadam Dam. Majumdar (1984) reported it to be very common and collected two males and three females from Itikyal, and one female from Kadam.

155. **Asian Palm-swift**
***Cypsiurus balasiensis* (J.E. Gray)**

Common. Not a resident within the Sanctuary, but affects the villages on the fringes between Tadlapet and Tapalapur, Janaram and Indhanpally, and in the vicinity of Utnoor. Young ones noted from March to April, but no nests were located. Sálim Ali collected a male and a juvenile (unsexed) specimen from Utnoor (Ali and Whistler 1934a). Majumdar (1984) found it to be common and collected a male specimen from Kadam.

156. **Crested Tree-swift**
***Hemiprocne coronata* (Tickell)**

Uncommon. Resident breeder. Seen frequenting open patches in teak mixed miscellaneous forest. Sálim Ali collected a pair of specimens from Utnoor (Ali and Whistler 1934a).

157. **Lesser Pied Kingfisher *Ceryle rudis* (Linné)**

Common. Resident breeder. Seen throughout the year along large and small waterbodies and paddy fields. Majumdar (1984) reported it to be not common, and collected a female specimen from Itikyal.

158. **Small Blue Kingfisher *Alcedo atthis* (Linné)**

Common. Resident breeder. Seen along the waterbodies and paddy fields throughout the Sanctuary. Sálim Ali collected a female specimen from Utnoor (Ali and Whistler 1934a.). Majumdar (1984) found it to be very common and collected two female specimens from Birsaipet.

159. **White-breasted Kingfisher**
***Halcyon smyrnensis* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary. Majumdar (1984) found it to be very common and collected a male specimen from Itikyal.

160. **Chestnut-headed Bee-eater**
***Merops leschenaulti* Vieillot**

Uncommon. Resident with local movements, breeding not recorded. Seen throughout the year in small numbers near Kadam Reservoir. Augmentation in numbers noted from September to December indicating seasonal local movements.

161. **Blue-tailed Bee-eater**
***Merops philippinus* Linné**

Uncommon. Resident with local movements, breeding not recorded. Frequently seen near Kadam Reservoir and also along the associated canal network.

162. **Small Bee-eater *Merops orientalis* Latham**

Common. Resident breeder. Affects cultivated and scrub tracts of the Sanctuary and is regularly seen along teak mixed miscellaneous forest especially along forest streams. Sálim Ali collected a male specimen from Utnoor (Ali and Whistler 1934a). Majumdar (1984) reported it to be very common and collected five male and two female specimens from Itikyal.

163. **Indian Roller *Coracias benghalensis* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary, more common along cultivated and scrub tracts. Nests observed in tree hollows. Ali and Whistler (1934a) reported this species to be abundant in the leafless deciduous forest in Utnoor. Majumdar (1984) found it to be common and collected a male specimen from Itikyal.

164. **Hoopoe *Upupa epops* Linné**

Common. Resident breeder. Although no nests were recorded, individuals carrying nesting material were observed. Seen throughout the Sanctuary, but more common along cultivated tracts and patches of teak plantation. Majumdar (1984) reported it to be not common, and collected a male specimen from Itikyal and a female specimen from Kadam.

165. **Indian Grey Hornbill**
***Ocyceros birostris* (Scopoli)**

Common. Resident with probable breeding status. Recorded in pairs affecting mixed miscellaneous forested tracts near village enclosures. No nests were sighted during the study period. Ali and Whistler (1934a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected one male specimen from Itikyal, and a pair from Kadam.

166. **Brown-headed Barbet**
***Megalaima zeylanica* (Gmelin)**

Uncommon. Resident, breeding not recorded. Occasionally sighted along the forested tracts adjacent to cultivated fields and also in teak mixed miscellaneous forest patches.

167. **Coppersmith Barbet**
***Megalaima haemacephala* (P.L.S. Müller)**

Common. Resident breeder. Seen in all types of forest patches within the Sanctuary.

168. **Eurasian Wryneck *Jynx torquilla* Linné**

Uncommon. Winter migrant. Occasionally recorded from open scrub and teak mixed miscellaneous forest tracts from October to December.

169. **Rufous Woodpecker**
***Celeus brachyurus* (Vieillot)**

Uncommon. Resident breeder. Observed affecting teak plantations, Teak Mixed Bamboo Forests and teak mixed miscellaneous forest patches. Fewer in numbers than other resident woodpecker species.

170. **Little Scaly-bellied Green Woodpecker**
***Picus xanthopygaeus* (J.E. Gray & G.R. Gray)**

Rare. Resident and probably a breeder within the Sanctuary; although no nests were noted. Usually seen singly affecting teak mixed miscellaneous forest and teak plantation patches between Rampur and Birsaipet. Majumdar (1984) reported it to be not very common and collected a female specimen from Birsaipet.

171. **Lesser Golden-backed Woodpecker**
***Dinopium benghalense* (Linné)**

Common. Resident breeder. Seen almost throughout the Sanctuary. Majumdar (1984) reported it to be very common and collected one male and two female specimens from Itikyal, a male from Kadam, and a female from Birsaipet.

172. **Great Black Woodpecker**
***Dryocopus javensis* (Horsfield)**

Rare. Probably a resident breeder. First recorded by the author in teak mixed miscellaneous forest near Rampur in February 1997, subsequently a few more individuals were sighted (Srinivasulu *et al.* 2001). It has been reported to be common from Surat Dangs to Western Ghats and Hills of Tamil Nadu (Ali and Ripley 1987). Occasional sightings, from Bastar (Ali 1951) and Udanti (Bharos 1992), Central India and Jyothimamidi in Vishakapatnam district, Eastern Ghats (Ripley *et al.* 1987), indicate that small populations exist sporadically between the Eastern Ghats and the Satpura Hills.

173. **Yellow-fronted Pied Woodpecker**
***Dendrocopos mahrattensis* (Latham)**

Uncommon. Resident breeder. Always seen in pairs throughout the Sanctuary. Majumdar (1984) found it to be common and collected a pair of specimens from Itikyal.

174. **Brown-capped Pygmy Woodpecker**
***Dendrocopos nanus* (Vigors)**

Uncommon. Resident breeder. Always seen in pairs in almost all the forest types within the Sanctuary. Sálim Ali reports sighting of a juvenile just out of nest being fed by its parents between Icchoda and Utnoor on March 31, 1932 (Ali and Whistler 1934a). Majumdar (1984) found it to be common and collected a pair of specimens from Birsaipet.

175. **Black-shouldered Woodpecker**
***Chrysocolaptes festivus* (Boddaert)**

Rare. Probably a resident breeder. Occasionally sighted in pairs or singly in teak mixed miscellaneous forest and teak plantation patches near Kadam, Udhumpur, Rampur, Birsaipet and Kalleda. Majumdar (1984) reported it to be rare and collected a female specimen from Kadam.

176. **Indian Pitta *Pitta brachyura* (Linné)**

Rare. Sighted thrice from November to January in 1997 and 1998.

177. **Singing Bush-lark *Mirafra cantillans* Blyth**

Uncommon. Probably a resident breeder. Occasionally sighted affecting fallow and open scrub areas of the Sanctuary.

178. **Jerdon's Bush-lark *Mirafra affinis* Blyth**

Uncommon. Probably a resident breeder. Regularly observed near cultivated and fallow fields, and open scrub patches of the Sanctuary.

179. **Red-winged Bush-lark**
***Mirafra erythroptera* Blyth**

Common. Resident breeder. Frequently sighted affecting fallow and cultivated fields, and open scrub patches of the Sanctuary.

180. **Ashy-crowned Finch-lark**
***Eremopterix grisea* (Scopoli)**

Common. Resident breeder. Frequently sighted in pairs and small parties affecting fallow fields and open scrub areas of the Sanctuary. Majumdar (1984) reported it to be very common and collected a pair of specimens from Itikyal.

181. **Rufous-tailed Finch-lark**
***Ammomanes phoenicurus* (Franklin)**

Common. Resident breeder. Frequently sighted affecting open scrub areas, and fallow and cultivated tracts of the Sanctuary. Ali and Whistler (1933c) recorded this species from Utnoor. Majumdar (1984) reported it to be not uncommon and collected a male specimen from Kadam.

182. **Greater Short-toed Lark**
***Calandrella brachydactyla* (Leisler)**

Common. Resident breeder. Regularly seen along fallow and open scrub patches. Seen in good numbers from November to March.

183. **Sykes's Crested Lark *Galerida deva* (Sykes)**

Common. Resident breeder. Frequently seen near open scrub areas and fallow fields along the village enclosures in the Sanctuary.

184. **Eastern Skylark *Alauda gulgula* Franklin**

Common. Resident breeder. Frequently sighted in the open scrub areas, and fallow and cultivated tracts of the Sanctuary. Numbers swell from October to March, indicating local movements.

185. **Dusky Crag-martin *Hirundo concolor* Sykes**

Uncommon. Probably a resident breeder. Seen regularly near Kadam Reservoir.

186. **Common Swallow *Hirundo rustica* Linné**

Common. Winter migrant. Large congregations observed to affect cultivated tracts within and around the Sanctuary from November to December.

187. **Wire-tailed Swallow *Hirundo smithii* Leach**

Common. Small resident population near Kadam and Itikyal regions. Numbers swell during winter months, indicating local movements. No breeding was noted. Majumdar (1984) reported it to be rather uncommon and collected a pair of specimens from Birsaipet.

188. **Streak-throated Swallow**
***Hirundo fluvicola* Blyth**

Uncommon. Probably a resident, breeding not recorded. Occasionally sighted near Kadam Reservoir and Kalleda, affects cultivated tracts and village outskirts.

189. **Red-rumped Swallow *Hirundo daurica* Linné**

Common. Resident breeder. Seen in association with House Swift near Kadam, Itikyal, Birsaipet and Utnoor. Numbers swell during winter months indicating local migration. Ali and Whistler (1933c) recorded this species from Utnoor. Majumdar (1984) reported occurrence of two sub species, namely the common *H.d. nipalensis* and the rather uncommon *H.d. erythropygia*. He collected two male and six female specimens of the former and two male specimens of the latter from Kadam.

190. **Southern Grey Shrike**
***Lanius meridionalis* Temminck**

Uncommon. Resident breeder. Frequently seen along open scrub and in the vicinity of village enclosures. Ali and Whistler (1933b) quoting from Ali's diary of 1925, state that this species was common near Talamadri, but add that it was not met with anywhere within 50 miles of Utnoor between April 1-10, 1932.

191. **Bay-backed Shrike**
***Lanius vittatus* Valenciennes**

Common. Resident breeder. Frequently affects open scrub and fallow fields within the Sanctuary. Ali and Whistler (1933b) recorded this species from Utnoor.

192. **Rufous-backed Shrike *Lanius schach* Linné**

Uncommon. Resident breeder. Frequently seen along open scrub, fallow fields and teak plantations within the Sanctuary. Majumdar (1984) found it to be common and collected one male and four female specimens from Itikyal.

193. **Brown Shrike *Lanius cristatus* Linné**

Uncommon. Winter migrant. Occasionally sighted in fallow fields, open scrub and teak plantations from November to January. Sálim Ali collected a specimen (unsexed) from Utnoor (Ali and Whistler 1933b).

194. **Eurasian Golden Oriole *Oriolus oriolus* (Linné)**

Common. Resident breeder. Frequently seen singly or in pairs in all types of forest within the Sanctuary. Ali and Whistler (1933b) reported this species to be fairly common in Utnoor. Majumdar (1984) found it to be common and collected a male specimen each from Itikyal and Kadam.

195. **Black-naped Oriole *Oriolus chinensis* Linné**
Rare. Winter migrant. Thrice sighted from December to January within the Sanctuary near Rampur, Birsaipet and Udhumpur.

196. **Black-headed Oriole**
***Oriolus xanthornus* (Linné)**
Uncommon. Probably a resident breeder. Sightings very few, but throughout the year. Seen in teak mixed miscellaneous forest and teak mixed bamboo forest patches in the Sanctuary. Ali and Whistler (1933b) reported this species to be fairly common in Utnoor and its environs.

197. **Black Drongo *Dicrurus macrocercus* Vieillot**
Common. Resident breeder. Very frequently seen in all types of forest patches, cultivated, fallow and open scrub areas of the Sanctuary. Ali and Whistler (1933b) reported it to be scarce, adding that Sálim Ali collected a female specimen from Utnoor. Majumdar (1984) reported it to be very common and collected a male specimen each from Itikyal and Kadam.

198. **Ashy Drongo *Dicrurus leucophaeus* Vieillot**
Uncommon. Winter migrant. Very few sighted in teak mixed bamboo forest and teak plantation patches. Seldom seen in scrub areas. Majumdar (1984) reported it to be not very common and collected a male specimen from Birsaipet.

199. **White-bellied Drongo**
***Dicrurus caerulescens* (Linné)**
Common. Resident breeder. Regularly sighted in teak mixed miscellaneous forest patches and around village fringes in the core area of the Sanctuary. Sálim Ali collected a female specimen from Utnoor (Ali and Whistler 1933b).

200. **Greater Racket-tailed Drongo**
***Dicrurus paradiseus* (Linné)**
Uncommon. Resident, probably breeding. Occasionally sighted in Teak Mixed Bamboo Forest and teak plantation patches of the Sanctuary. Ali and Whistler (1933b) did not record this species from Utnoor.

201. **Ashy Woodswallow *Artamus fuscus* Vieillot**
Common. Resident, no nesting recorded but probably breeds within the Sanctuary. Regularly seen near village fringes and open scrub.

202. **Grey-headed Starling**
***Sturnus malabaricus* (Gmelin)**
Uncommon. Resident, probably breeds within the Sanctuary. Affects open scrub near teak plantations. Populations swell during winter months, indicating local migration. Majumdar (1984) reports sighting of this species.

203. **Brahminy Starling**
***Sturnus pagodarum* (Gmelin)**
Common. Resident breeder. Seen frequently near cultivation and in open scrub. Sálim Ali collected a male from Utnoor (Ali and Whistler 1933b). Majumdar (1984) found it to be common and collected a male and two females from Itikyal, five males and a female from Kadam, and a female from Birsaipet.

204. **Rosy Starling *Sturnus roseus* (Linné)**
Common. Winter migrant. Regularly seen from August to February in medium to large flocks along cultivation, scrub and teak mixed miscellaneous forest patches.

205. **Common Starling *Sturnus vulgaris* Linné**
Uncommon. Winter migrant. Unlike Rosy Starling, these were sighted only on a few occasions along cultivation and open scrub patches.

206. **Asian Pied Myna *Sturnus contra* Linné**
Common. Resident breeder. Affects cultivation, open scrub, and teak mixed forest patches especially along waterbodies, more common between Birsaipet and Utnoor.

207. **Common Myna *Acridotheres tristis* (Linné)**
Common. Ubiquitous resident breeder. Affects all types of forest patches within the Sanctuary. Ali and Whistler (1933b) recorded this species from Utnoor. Majumdar (1984) reports it to be very common and collected a female specimen from Itikyal.

208. **Jungle Myna *Acridotheres fuscus* (Wagler)**
Uncommon. Probably a resident breeder. Infrequent sightings in teak mixed miscellaneous forest patches in areas of Janaram and Nirmal Forest Division comprising the Sanctuary.

209. **Indian Treepie**
***Dendrocitta vagabunda* (Latham)**
Common. Resident breeder. Affects teak mixed miscellaneous forest, teak mixed bamboo forest, teak plantation, scrub patches and near

villages. Majumdar (1984) reported it to be very common and collected two male specimens from Itikyal.

210. **House Crow** ***Corvus splendens*** **Vieillot**

Common. Resident breeder. Encountered throughout the Sanctuary.

211. **Jungle Crow** ***Corvus macrorhynchos*** **Wagler**

Common. Resident breeder. Although not a match in numbers to the Common Crow, it is frequently seen throughout the Sanctuary.

212. **Common Woodshrike**
Tephrodornis pondicerianus **(Gmelin)**

Common. Resident breeder. Affects teak plantation, teak mixed miscellaneous forest and teak mixed bamboo forest patches. Ali and Whistler (1933b) recorded this species from areas adjoining Utnoor. Majumdar (1984) found it to be common and collected a male specimen from Itikyal.

213. **Large Cuckoo-shrike** ***Coracina macei*** **(Lesson)**

Common. Resident breeder. Frequently seen in teak plantation and teak mixed miscellaneous forest patches of the Sanctuary. Ali and Whistler (1933b) recorded this species from Utnoor.

214. **Black-headed Cuckoo-shrike**
Coracina melanoptera **Rüppell**

Common. Resident breeder. Affects patches of teak mixed miscellaneous forest and bamboo plantation in the Sanctuary.

215. **Scarlet Minivet**
Pericrocotus flammeus **(Forster)**

Common. Resident breeder. Affects teak plantation and teak mixed miscellaneous forest in the Sanctuary.

216. **Small Minivet**
Pericrocotus cinnamomeus **(Linné)**

Common. Resident breeder. Seen regularly in teak plantation and teak mixed miscellaneous forest in the Sanctuary. Ali and Whistler (1933b) recorded this species from Utnoor.

217. **White-bellied Minivet**
Pericrocotus erythropygius **(Jerdon)**

Uncommon. Probably a resident breeder. Regularly seen in scrub and teak mixed miscellaneous forest in the Sanctuary. Ali and Whistler (1933b) did not record this species from Utnoor.

218. **Common Iora** ***Aegithina tiphia*** **(Linné)**

Common. Resident breeder. Affects all types of forest in the Sanctuary. Ali and Whistler (1933a) did not record this species from Utnoor. Majumdar (1984) reports it to be very common and collected a male specimen from Itikyal.

219. **Gold-fronted Chloropsis**
Chloropsis aurifrons **(Temminck)**

Uncommon. Resident breeder. Regularly seen in all types of forest in the Sanctuary.

220. **Jerdon's Chloropsis**
Chloropsis cochinchinensis **(Gmelin)**

Common. Resident breeder. Regularly seen in all types of forest in the Sanctuary.

221. **Red-whiskered Bulbul**
Pycnonotus jocosus **(Linné)**

Rare. Sighted six times near Utnoor and Birsaipet regions. Ali and Whistler (1933a) reported it to be conspicuously absent from Utnoor.

222. **Red-vented Bulbul** ***Pycnonotus cafer*** **(Linné)**

Common. Resident breeder. Regularly seen in all types of forest in the Sanctuary. Majumdar (1984) reported it to be very common and collected three males and five females from Itikyal.

223. **White-browed Bulbul**
Pycnonotus luteolus **(Lesson)**

Common. Resident breeder. Regularly seen in all types of forest in the Sanctuary.

224. **Spotted Babbler**
Pellorneum ruficeps **Swainson**

Uncommon. Resident breeder. Occasionally sighted in teak mixed bamboo forest and teak plantation. Ali and Whistler (1933a) did not come across this species from Utnoor.

225. **Rufous-bellied Babbler**
Dumetia hyperythra **(Franklin)**

Common. Resident breeder. Affects open scrub and teak mixed miscellaneous forest in the Sanctuary. Sálim Ali collected a male from Utnoor (Ali and Whistler 1933a).

226. **Yellow-eyed Babbler**
Chrysomma sinense **(Gmelin)**

Common. Resident breeder. Affects open scrub, near villages, teak mixed miscellaneous forest and teak plantation within the Sanctuary. Ali and Whistler (1933a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected three males and one female from Kadam, and one female from Birsaipet.

227. **Common Babbler *Turdoides caudatus* (Dumont)**
Common. Resident breeder. Seen throughout the Sanctuary.

228. **Large Grey Babbler**
***Turdoides malcolmi* (Sykes)**
Common. Resident breeder. Affects open scrub, fallow fields and teak mixed miscellaneous forest. Ali and Whistler (1933a) reported it as absent from Utnoor.

229. **Jungle Babbler *Turdoides striatus* (Dumont)**
Common. Resident breeder. Seen throughout the Sanctuary. Ali and Whistler (1933a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected two male specimens from Itikyal, a male and six females from Kadam, and a male from Birsaipet.

230. **White-headed Babbler**
***Turdoides affinis* (Jerdon)**
Common. Resident breeder. Seen throughout the Sanctuary, but seems to prefer open scrub, cultivated fields and teak mixed miscellaneous forest over other types of habitat.

231. **Asian Brown Flycatcher**
***Muscicapa dauurica* Pallas**
Uncommon. Probably a seasonal local migrant. Frequently encountered during winter in well-wooded tracts of the Sanctuary. Sálim Ali collected two males and one female from Utnoor (Ali and Whistler 1933a).

232. **Brown-breasted Flycatcher**
***Muscicapa muttui* (Layard)**
Rare. Probably a straggler. A total of eight sightings, all from teak mixed bamboo forest, during the study period. Ali and Whistler (1933a) did not record this species from Utnoor.

233. **Red-throated Flycatcher**
***Ficedula parva* (Bechstein)**
Uncommon. Probably a seasonal local migrant. Frequently encountered during winter in well-wooded tracts of the Sanctuary.

234. **Ultramarine Flycatcher**
***Ficedula superciliaris* Jerdon**
Uncommon. Winter migrant. Frequently encountered in all types of forest within the Sanctuary.

235. **Tickell's Blue-flycatcher**
***Cyornis tickelliae* Blyth**
Common. Resident breeder. Affects well-wooded forested tracts with bamboo and good undergrowth. Ali and Whistler (1933a) recorded this species from Utnoor. Majumdar (1984) reported it to be very common and collected one male and two females from Birsaipet.

236. **Verditer Flycatcher**
***Eumyias thalassina* (Swainson)**
Common. Winter migrant. Frequently seen along well-wooded forested tracts with good undergrowth. Ali and Whistler (1933a) did not record this species from Utnoor. Majumdar (1984) collected a male from Birsaipet.

237. **Grey-headed Flycatcher**
***Culicicapa ceylonensis* (Swainson)**
Uncommon. Probably a resident breeder. Regularly sighted in well-wooded forested tracts with good undergrowth. Ali and Whistler (1933a) did not record this species from Utnoor.

238. **White-browed Fantail-flycatcher**
***Rhipidura aureola* Lesson**
Uncommon. Probably a resident breeder. Regularly met with in patches of teak mixed miscellaneous, teak mixed bamboo and teak plantation. Sálim Ali collected a female from Utnoor (Ali and Whistler 1933a). Majumdar (1984) reported it to be rather uncommon and collected a male and two females from Birsaipet.

239. **White-throated Fantail-flycatcher**
***Rhipidura albicollis* (Vieillot)**
Uncommon. Resident breeder. Affects all types of forest patches within the Sanctuary. Sálim Ali collected a male from Utnoor (Ali and Whistler 1933a).

240. **Asian Paradise-flycatcher**
***Terpsiphone paradisi* (Linné)**
Common. Resident breeder. Frequently seen throughout the Sanctuary. Sálim Ali collected a pair of specimens from Utnoor (Ali and Whistler 1933a). Majumdar (1984) found it to be common and collected a male and two females from Birsaipet.

241. **Black-naped Monarch-flycatcher**
***Hypothymis azurea* (Boddaert)**
Uncommon. Winter migrant. Frequently met with in well-wooded patches with good bamboo and undergrowth during winter season. Sálim Ali collected an adult male specimen from Utnoor (Ali and

Whistler 1933a). Majumdar (1984) collected a female specimen from Itikyal and two male specimens from Birsaipet.

242. **Streaked Fantail-warbler**
***Cisticola juncidis* (Rafinesque)**

Common. Resident breeder. More commonly found along cultivated and fallow fields and open scrub in the Sanctuary. Sálim Ali collected two male specimens from Utnoor (Ali and Whistler 1933b).

243. **Franklin's Prinia**
***Prinia hodgsonii* Blyth**

Common. Resident breeder. Seen frequently throughout the Sanctuary. Sálim Ali collected a male specimen from Utnoor (Ali and Whistler 1933b).

244. **Rufous-fronted Prinia**
***Prinia buchanani* Blyth**

Uncommon. Probably a resident breeder. Frequently met with in small groups hopping on forest floor near Birsaipet, Utnoor, Kadam and Kalleda. Ali and Whistler (1933b) did not record this species from Utnoor.

245. **Plain Prinia *Prinia inornata* Sykes**

Common. Resident breeder. Affects cultivation and open scrub in nearby villages.

246. **Ashy Prinia *Prinia socialis* Sykes**

Common. Resident breeder. Frequently met with in all types of forest especially near streams, cultivated fields and open scrub. Sálim Ali collected a female specimen from near Utnoor (Ali and Whistler 1933b). Majumdar (1984) reported it to be fairly common and collected a female specimen from Kadam and two male specimens from Birsaipet.

247. **Jungle Prinia *Prinia sylvatica* Jerdon**

Common. Resident breeder. Affects well-wooded and open scrub areas with good undergrowth. Sálim Ali collected a female (?) specimen from Utnoor (Ali and Whistler 1933b).

248. **Common Tailorbird**
***Orthotomus sutorius* (Pennant)**

Common. Resident breeder. Frequently seen throughout the Sanctuary. Ali and Whistler (1933b) reported it to be fairly common near Nirmal. Majumdar (1984) reported it to be fairly common and collected two males and four females from Itikyal, a pair from Birsaipet, and a male from Kadam.

249. **Bristled Grass-warbler**
***Chaetornis striatus* (Jerdon)**

Rare. Once sighted in November 1997 near Kadam Reservoir.

250. **Indian Great Reed Warbler**
***Acrocephalus stentoreus* (Hemprich & Ehrenberg)**

Uncommon. Winter migrant. Infrequently met with near large waterbodies among reeds.

251. **Blyth's Reed-warbler**
***Acrocephalus dumetorum* Blyth**

Common. Winter migrant. Frequently met with throughout the Sanctuary near large waterbodies with reeds. Majumdar (1984) reported it to be rather uncommon and collected a pair of specimens from Itikyal, and three males and a female from Kadam.

252. **Booted Warbler**
***Hippolais caligata* (Lichtenstein)**

Uncommon. Winter migrant. Infrequently seen in open scrub and teak mixed miscellaneous forest throughout the Sanctuary.

253. **Common Lesser Whitethroat**
***Sylvia curruca* (Linné)**

Uncommon. Winter migrant. Frequently seen in open scrub throughout the Sanctuary. Majumdar (1984) reported it to be rather uncommon and collected a male and two females from Itikyal, and a female from Kadam.

254. **Tickell's Warbler**
***Phylloscopus affinis* (Tickell)**

Rare. One record from Rampur in January 1998.

255. **Common Chiffchaff**
***Phylloscopus collybita* (Vieillot)**

Common. Winter migrant. Frequently seen with in shrubs and undergrowth throughout the Sanctuary, up to last week of March.

256. **Greenish Leaf-warbler**
***Phylloscopus trochiloides* (Sundevall)**

Uncommon. Infrequently seen in all types of forest patches within the Sanctuary.

257. **Oriental Magpie-robin**
***Copsychus saularis* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary. Seasonal fluctuation in their numbers, suggests local movements. Sálim Ali reported sighting of a pair on March 30, 1932 near Nirmal (Ali and Whistler 1933a). Majumdar (1984) reported it to be very common and collected three pairs from Itikyal, a male each from Kadam and Birsaipet.

258. **White-rumped Shama**
***Copsychus malabaricus* (Scopoli)**

Rare. A total of six sightings throughout the study period.

259. **Black Redstart**
***Phoenicurus ochruros* (Gmelin)**

Rare. A total of 15 sightings during the study period. Ali and Whistler (1933a) recorded this species from Utnoor. Majumdar (1984) reported it to be rather uncommon and collected three males and a female from Itikyal, and a female from Birsaipet.

260. **Common Stonechat *Saxicola torquata* (Linné)**

Common. Winter migrant. Frequently seen in open scrub, fallow fields and teak mixed miscellaneous forest patches. Majumdar (1984) reported it to be fairly common and collected a male from Kadam.

261. **Pied Bushchat *Saxicola caprata* (Linné)**

Uncommon. Probably a resident breeder. Regularly seen throughout the Sanctuary with numbers increasing during winter with the influx of the northern, migrant race *S.c. bicolor*. Breeding recorded in April. Sálim Ali collected a male from Utnoor (Ali and Whistler 1933a). Majumdar (1984) reported it to be rather common and collected two females from Itikyal and a male from Birsaipet.

262. **Indian Robin *Saxicoloides fulicata* (Linné)**

Common. Resident breeder. Regularly seen throughout the Sanctuary. Sálim Ali collected a male and a female of this species from Utnoor (Ali and Whistler 1933a). Majumdar (1984) reported it to be exceedingly common and collected ten male and eight female specimens from Itikyal, and a male from Kadam.

263. **Blue Rock-thrush *Monticola solitarius* (Linné)**

Uncommon. Winter migrant. Frequently seen along open scrub and teak mixed miscellaneous forest interspersed with hillocks. Sálim Ali collected a male from Utnoor (Ali and Whistler 1933a).

264. **Orange-headed Thrush**
***Zoothera citrina* (Latham)**

Uncommon. Resident breeder. Regularly seen in teak mixed miscellaneous forest, teak mixed bamboo forest and teak plantation. Copulating pairs were observed during June 1998. Sálim Ali collected a pair of specimens from areas adjoining Utnoor (Ali and Whistler 1933a). Majumdar (1984) reported it to be not common and collected a pair from Birsaipet.

265. **Eurasian Blackbird *Turdus merula* Linné**

Uncommon. Probably a seasonal local migrant. Frequently met with in open scrub, nearby cultivated and fallow fields, and teak mixed miscellaneous forest.

266. **Great Tit *Parus major* Linné**

Common. Resident breeder. Regularly seen affecting well-wooded tracts of the Sanctuary, more commonly in the vicinity of Pembi and Itikyal areas. Ali and Whistler (1933a) recorded this species from Utnoor. Majumdar (1984) found it to be common and collected six males and five females from Itikyal, and a male from Birsaipet.

267. **Black-lored Yellow Tit**
***Parus xanthogenys* Vigors**

Uncommon. Resident breeder. Infrequently seen in well-wooded areas of the Sanctuary preferring hilly tracts. Sálim Ali collected a specimen (unsexed) from Utnoor (Ali and Whistler 1933a).

268. **Chestnut-bellied Nuthatch**
***Sitta castanea* Lesson**

Uncommon. Probably a resident breeder. Frequently seen in teak plantation patches, in a mango orchard (near Kadam) and forest nursery (Tadlapet and Kadam).

269. **Velvet-fronted Nuthatch**
***Sitta frontalis* Swainson**

Rare. Probably a resident breeder. Met with twice, near Rampur and Alinagar, during November 1997 and January 1998.

270. **Spotted Creeper *Salpornis spilonotus* (Franklin)**

Uncommon. Probably a resident breeder. Infrequently seen in teak mixed miscellaneous forest and teak plantation patches near Alinagar, Donga- pally, Rampur, Udhumpur, Dosthnagar, Kalleda, Indhanpally, Birsaipet and Itikyal areas. Ali and Whistler (1933a) did not come across this species at Utnoor. Majumdar (1984) reported it for the first time from Adilabad district and collected two females from Kotpally near the border of Andhra Pradesh and Maharashtra. Recently, this species was reported from Kawal Wildlife Sanctuary in May 1997 (Pittie 1997).

271. **Oriental Tree Pipit *Anthus hodgsoni* Richmond**

Rare. Twice sighted in small flocks (4 and 9 birds) in January 1998 and February 1999 near Birsaipet and

Rampur areas. Majumdar (1984) reported it to be rather uncommon and collected a male specimen from Birsaipet.

272. **Paddyfield Pipit**
***Anthus rufulus* Vieillot**

Common. Resident breeder. Frequently seen in open scrub, cultivated and fallow fields within the Sanctuary.

273. **Forest Wagtail**
***Dendronanthus indicus* (Gmelin)**

Uncommon. Winter migrant. Infrequently seen in teak mixed miscellaneous forest and teak plantation patches.

274. **Yellow Wagtail *Motacilla flava* Linné**

Uncommon. Winter migrant. Two subspecies, *M.f. thunbergi* (grey-headed race) and the less common *M.f. beema* (blue-headed race) recorded near water edges throughout the Sanctuary.

275. **Citrine Wagtail *Motacilla citreola* Pallas**

Common. Winter migrant. Seen in small flocks near water edges throughout the Sanctuary.

276. **Grey Wagtail *Motacilla cinerea* Tunstall**

Uncommon. Winter migrant. Infrequently met with near stream beds and water edges throughout the Sanctuary. Sálim Ali collected one female from Utnoor (Ali and Whistler 1933c).

277. **White Wagtail *Motacilla alba* Linné**

Common. Winter migrant. Seen along edges of waterbodies, stream beds, and cultivated and fallow fields. Majumdar (1984) found it to be common, and collected a female from Birsaipet.

278. **Large Pied Wagtail**
***Motacilla maderaspatensis* Gmelin**

Common. Resident breeder. Affects open scrub, cultivated and fallow fields, and nearby village enclosures throughout the Sanctuary. Nests were observed during March to April and were located near waterbodies, holes in the Kadam Dam, bridges and also in wells. Majumdar (1984) found it to be common and collected a male specimen from Itikyal.

279. **Thick-billed Flowerpecker**
***Dicaeum agile* (Tickell)**

Common. Resident breeder. Seen throughout the Sanctuary. Ali and Whistler (1933c) recorded it from Utnoor.

280. **Tickell's Flowerpecker**
***Dicaeum erythrorhynchos* (Latham)**

Common. Resident breeder. Seen throughout the Sanctuary. Ali and Whistler (1933c) reported it as not common from areas adjoining Utnoor.

281. **Purple-rumped Sunbird**
***Nectarinia zeylonica* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary, but sightings were fewer in thick teak mixed bamboo forest. Sálim Ali reports a sighting on October 15, 1925 from Nirmal (Ali and Whistler 1933c). Majumdar (1984) reported it to be quite common and collected a female specimen from Kadam.

282. **Purple Sunbird *Nectarinia asiatica* (Latham)**

Common. Resident breeder. Affects teak mixed miscellaneous forest, teak plantation patches, nurseries, orchards, cultivated and fallow fields, and also near human habitations. Majumdar (1984) reported it to be very common and collected a pair of specimens from Itikyal.

283. **Little Spiderhunter**
***Arachnothera longirostra* (Latham)**

Uncommon. Probably a resident breeder. Flocks of 3 to 8 individuals regularly seen in mixed feeding flocks with sunbirds, white-eyes and flycatchers near Alinagar and Rampur areas especially along the core area boundary.

284. **Oriental White-eye**
***Zosterops palpebrosus* (Temminck)**

Common. Resident breeder. Frequently seen throughout the Sanctuary, affecting teak mixed miscellaneous forest, teak plantation patches, nurseries and orchards. Ali and Whistler (1933c) recorded this species from Utnoor. Majumdar (1984) reported it to be rather uncommon and collected two male specimens from Kadam.

285. **House Sparrow *Passer domesticus* (Linné)**

Common. Resident breeder. Ubiquitous in the Sanctuary, more common near human habitations. Majumdar (1984) reported it to be very common and collected a female specimen from Kadam.

286. **Yellow-throated Sparrow**
***Petronia xanthocollis* (Burton)**

Uncommon. Resident breeder. Infrequently seen near cultivated tracts within the Sanctuary. Sálim Ali collected a male specimen from areas adjoining Utnoor (Ali and Whistler 1933c). Majumdar (1984) reported it to be very common and collected 19 males and 12 females from Itikyal, and a male and two females from Birsaipet.

287. **Baya Weaver *Ploceus philippinus* (Linné)**

Common. Resident breeder. Affects all forest types throughout the Sanctuary, being more common near cultivated fields, human habitations and stream beds. Practice nests were found deep inside the teak mixed bamboo forests too. Sálim Ali collected one male from Utnoor (Ali and Whistler 1933c). Majumdar (1984) reports it to be not common, and collected 18 males and 14 females from Kadam.

288. **Streaked Weaver *Ploceus manyar* (Horsfield)**

Uncommon. Resident breeder. Regularly seen along the well-wooded tracts of the Sanctuary, especially in the vicinity of Kadam Reservoir.

289. **Red Munia *Amandava amandava* (Linné)**

Common. Resident breeder. Frequently seen along the cultivated tracts of the Sanctuary, especially between Rampur and Utnoor. Sálim Ali collected a male, a female and two immature specimens from Utnoor (Ali and Whistler 1933c). Majumdar (1984) reports it to be quite common and collected a female from Kadam.

290. **White-throated Munia**
***Lonchura malabarica* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary near cultivated tracts and open scrub. Ali and Whistler (1933c) recorded this species from Utnoor. Majumdar (1984) reported it to be very common and collected two females from Itikyal and a pair from Kadam.

291. **White-rumped Munia *Lonchura striata* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary near cultivated tracts.

292. **Spotted Munia *Lonchura punctulata* (Linné)**

Common. Resident breeder. Seen throughout the Sanctuary, affecting open scrub, teak mixed miscellaneous forest and cultivated patches. Ali and Whistler (1933c) did not record this species from Utnoor. Majumdar (1984) reported it to be very common, and collected two males and four females from Itikyal and a pair from Kadam.

293. **Black-headed Munia**
***Lonchura malacca* (Linné)**

Common. Resident breeder. Seen restricted to paddies and other cultivated tracts within the Sanctuary.

294. **Common Rosefinch *Carpodacus erythrinus* (Pallas)**

Uncommon. Winter migrant. Seen a few times in teak mixed miscellaneous forest patches near Rampur, Janaram and Indhanpally. Ali and Whistler (1933c) did not record this species from Utnoor. Majumdar (1984) reported it as rather uncommon, and collected a male and four females from Itikyal.

Ali and Whistler (1933a, b, c; 1934a, b) recorded about 111 species from Utnoor, and 16 species that were reported later or during the present survey as conspicuously absent here (Table 2). Majumdar (1984) reported a total of 95 species from Birsaipet, Kadam and Itikyal. A total of nine species that were recorded earlier by Ali (1933-34) and Majumdar (1984) but not during the present survey are Darter *Anhinga melanogaster* (Pennant), Little Green Heron *Butorides striatus* (Linné), Pintail Snipe *Gallinago stenura* (Bonaparte), Green Sandpiper *Tringa ochropus* Linné, Stork-billed Kingfisher *Halcyon capensis* (Linné), Bluethroat *Luscinia svecica* (Linné), Desert Wheatear *Oenanthe deserti* (Temminck) between Utnoor and Nirmal, Green Munia *Amandava formosa* (Latham) and Red-headed Bunting *Emberiza bruniceps* Brandt.

CONCLUSIONS

The secure and dense teak mixed forest, teak mixed bamboo forest and teak plantations interspersed with miscellaneous species provide good habitat for rich avifaunal diversity in Kawal Wildlife Sanctuary. The bird diversity at Kawal represents 90% of the families and 57% of the species reported from Andhra Pradesh (Taher and Pittie 1989, 1994). The Sanctuary is contiguous with a vast tract of forest between the Godavari river basin in the south, the Wardha river basin in the north and Indravathi river basin in the northeast to east. Sighting of rarer bird species (e.g. *Dryocopus javensis*, *Chrysocolaptes festivus*, *Salpornis spilonotus*, *Arachnothera longirostra*) indicates that regular thorough surveys will yield interesting information on distribution patterns of some species that were either not reported earlier from this region or are sparsely distributed through central India. Although reported earlier from nearby areas, both the Forest Owlet *Heteroglaux blewitti* and Jerdon's Courser *Rhinoptilus bitorquatus* were not sighted during the present survey, or in the Eturnagaram Wildlife Sanctuary (Srinivasulu *under prep.*) further downstream the Godavari river. The habitat at Kawal is increasingly coming under biotic pressure due to the escalating human population in and around the Sanctuary. Unprecedented changes in the

Table 2: List of species not recorded by Ali (1933-34) but seen later or during the present survey

Order	Family	Scientific Name	Common Name	Entry No.*
Galliformes	Phasianidae	*Francolinus pondicerianus*	Grey Francolin	71
Charadriiformes	Charadriidae	*Pluvialis fulva*	Pacific Golden-plover	97
	Recurvirostridae	*Himantopus himantopus*	Black-winged Stilt	111
Strigiformes	Strigidae	*Otus bakkamoena*	Collared Scops-owl	143
Passeriformes	Laniidae	*Lanius excubitor*	Southern Grey Shrike	190
	Dicruridae	*Dicrurus paradiseus*	Racket-tailed Drongo	200
	Campephagidae	*Pericrocotus erythropygius*	White-bellied Minivet	217
	Pycnonotidae	*Pycnonotus jocosus*	Red-whiskered Bulbul	221
	Muscicapidae	*Pellorneum ruficeps*	Spotted Babbler	224
		Turdoides malcolmi	Large Grey Babbler	228
		Muscicapa muttui	Brown-breasted Flycatcher	232
		Eumyias thalassina	Verditer Flycatcher	236
		Culicicapa ceylonensis	Grey-headed Flycatcher	237
		Prinia buchanani	Rufous-fronted Prinia	244
	Estrildidae	*Lonchura punctulata*	Spotted Munia	292
	Fringillidae	*Carpodacus erythrinus*	Common Rosefinch	294

*Order of appearance same as in the annotated checklist

habitat due to anthropogenic activities such as forest clearing for agriculture will affect the avifaunal diversity considerably, as has been observed elsewhere in Andhra Pradesh (Vasudeva Rao *et al.* 1997).

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THE FIRST RECORDINGS OF CALLS OF THE JERDON'S COURSER *RHINOPTILUS BITORQUATUS* (BLYTH), FAMILY GLAREOLIDAE[1]

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The call of the Critically Endangered Jerdon's Courser (*Rhinoptilus bitorquatus*) was unknown until now. The short disyllabic call attributed to the Jerdon's Courser was recorded and identified within the Sri Lankamaleswara Wildlife Sanctuary during dawn and dusk. Details of the calling period, duration of the call and spectrogram are given.

Key words: Jerdon's Courser, *Rhinoptilus bitorquatus*, call recording, call description, spectrogram

INTRODUCTION

Jerdon's Courser *Rhinoptilus bitorquatus* (Charadriiformes: Glareolidae) is a nocturnal cursorial bird that has been categorized as Critically Endangered on the IUCN Red List (Hilton-Taylor 2000), because it is believed to have a small and declining population. It was thought to be extinct for more than 80 years until its rediscovery in 1986 (Bhushan 1986). Since then, it has been seen in only a few restricted areas of the scrub jungle in Andhra Pradesh, India (BirdLife International 2001). Jerdon's Coursers are difficult to see because of their nocturnal habits, and this has hampered efforts to survey the population size and distribution of the species. Many areas in and around the Sri Lankamaleswara Wildlife Sanctuary have habitats that are superficially similar to places where Jerdon's Coursers are known to occur. A new method has been developed for detecting their presence by placing tracking strips upon which the birds leave their distinctive footprints (Jeganathan *et al.* 2002). Surveys using this method have recently detected the species in some new areas, but more rapid surveys might be possible if the bird's calls could be recognized. The only published reports on the calls of the Jerdon's Courser are "a plaintive cry" (Ali and Ripley 1983), "very sad; a single note and very soft" (Bhushan 1990), "not very vocal; plaintive cry: he-he-he-he-he" (Kazmierczak and van Perlo 2000) and "kwick- kweek- kwick- kweek- kweek- kweek- kweek", as described by some bird trappers (Samant and Elangovan 1997). The latter description, however, was thought to be more likely that of the Stone-curlew *Burhinus oedicnemus* (Samant and Elangovan 1997). This paper describes a successful effort at identifying and recording calls of the Jerdon's Courser.

METHODS

Since the Jerdon's Courser is nocturnal, efforts were made to listen for, and record, its calls during dawn and dusk in the places where it was known to occur in the Sri Lankamaleswara Wildlife Sanctuary, near Reddipalle, Cuddapah district, Andhra Pradesh, India (Jeganathan *et al.* 2002). Calls were monitored from about sunset to about 80 minutes after sunset, and from about 80 minutes before sunrise up to sunrise.

To discriminate the Jerdon's Courser calls from those of the other birds in the Sanctuary, it was necessary to eliminate the calls of other species. Other crepuscular and nocturnal species that are now known to occur within the Sri Lankamaleswara Wildlife Sanctuary are Red-wattled Lapwing *Vanellus indicus*, Stone-curlew, Eurasian Eagle-owl *Bubo bubo*, Collared Scops-owl *Otus bakkamoena*, Spotted Owlet *Athene brama*, Indian Jungle Nightjar *Caprimulgus indicus*, Jerdon's Nightjar *Caprimulgus atripennis*, Common Indian Nightjar *Caprimulgus asiaticus* and Franklin's Nightjar *Caprimulgus affinis*. Since the beginning of the study, the calls of these species have been recorded and catalogued along with the calls of other species occurring in the Sanctuary, which could possibly be confused with that of the Jerdon's Courser.

The recording equipment used was a Marantz PMD222 tape recorder with an Audio Technica AT815 unidirectional microphone, with no sound filters. Searches, listening and recording were carried out mainly during clear still nights. Recordings of calls were analyzed using the Canary 1.2.4 sound analysis package (Charif *et al.* 1993) on a Power Macintosh.

RESULTS

A call of the type that was later attributed to the Jerdon's Courser was heard (by PJ) on February 17, 2001, within the core area for Jerdon's Courser sightings in the Sri Lankamaleswara Wildlife Sanctuary. A Jerdon's Courser was sighted in the direction of the call a few seconds after it was heard. Unfortunately, it was not possible to get a recording of this call. Identical calls were heard again on June 19, October 22 and October 25, 2001, but no birds were seen and no recordings were obtained.

The first recording of the call was obtained on November 12, 2001 at 1812 hrs local time and again on November 13, 2001, at 1820 hrs, although the calling bird was not seen on either occasion. On November 14, 2001 the call was heard again twice, at 1816 hrs and a Jerdon's Courser was seen briefly (by SW) where the call was heard from. The bird flew off when illuminated by a spotlight and called twice in flight. Final confirmation that the call was made by a Jerdon's Courser was obtained on May 17, 2002 at 1818 hrs (by PJ), when a Jerdon's Courser was observed while it was calling, before dusk in ample sunlight. The distance between the observer and the bird was not more than 50 m in all of these instances.

Description of the call: The short disyllabic call consists of a high-pitched first syllable, and rapidly descending second syllable, which can be rendered as either "kwik-koo ... kwik-koo ... kwik-koo ... kwik-koo..." or "yak-wak ... yak-wak ... yak-wak ... yak-wak...". We refer to each pair of syllables as a call. Birds have been heard to give between 2 and 16 calls in a sequence at a rate of about one call per second. On one occasion, the first syllable of the single call was heard several times and then the bird spontaneously called, "kwik...kwik...kwik...kwik...kwik...kwik-koo...kwik-koo...".

The calling period is quite brief, starting 45-50 minutes after sunset and continuing for a few minutes to about 20 minutes. Calls were often heard from more than one place. At the most, they were heard from three different places up to about 200 m apart within a period of a few minutes. The possibility of the same bird moving and calling in such a case was unlikely, because of the pattern of calling in some instances. It has been estimated that the call can be heard from a distance of 200 to 250 m. It appears that the birds call mainly at dusk, but the frequency of calling is likely to depend upon the time of year and the weather.

Figure 1 shows a spectrogram of a single Jerdon's Courser call, consisting of two repeated syllables, each separated by an interval of 60 milliseconds (mS). The majority of the energy within the Jerdon's Courser call occurs between 1 and 4 kHz, with the syllables showing three distinct bands throughout the frequency range. In effect, there are three notes at three different frequencies (1 kHz, 2 kHz, 3.5 kHz), which make up each syllable. The calls are repeated in a series with gaps of about 500 mS between the end of one call and the beginning of the next (Fig. 2).

DISCUSSION

The call recorded by us does not resemble closely any of the previous verbal descriptions. These may refer to calls not detected by us so far, or the previous identifications may have been mistaken. The identified call of the Jerdon's Courser may be of value as it could

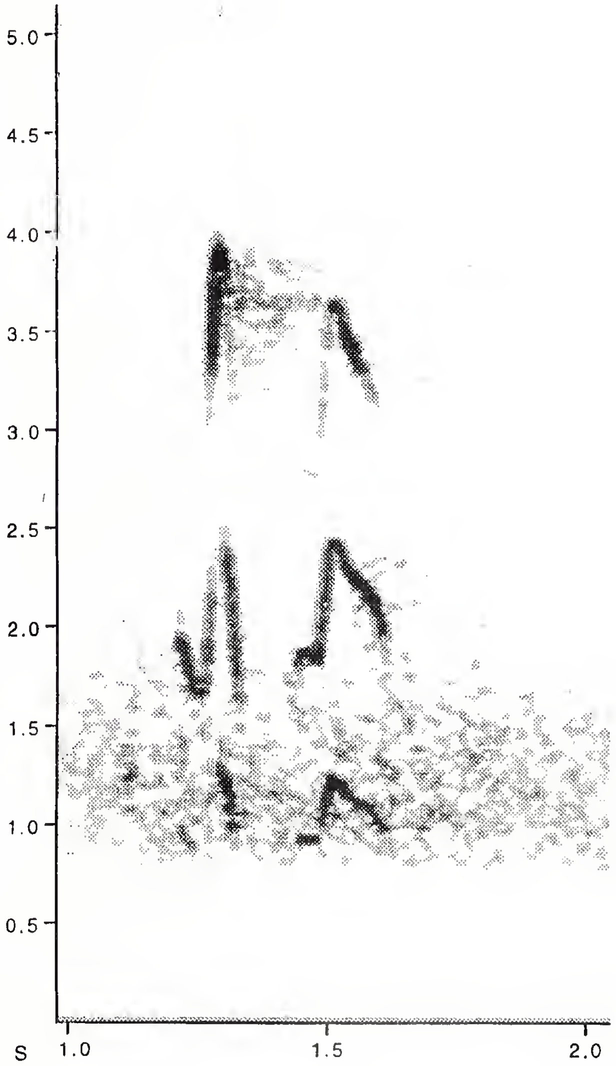

Fig. 1: Spectrogram (time v. frequency) of a complete Jerdon's Courser call showing 2 syllables separated by an interval. The spectrogram was produced by Canary 1.2.4, grid resolutions 5.8 ms, 10.77 Hz. [Y-axis=kHz, X-axis=S].

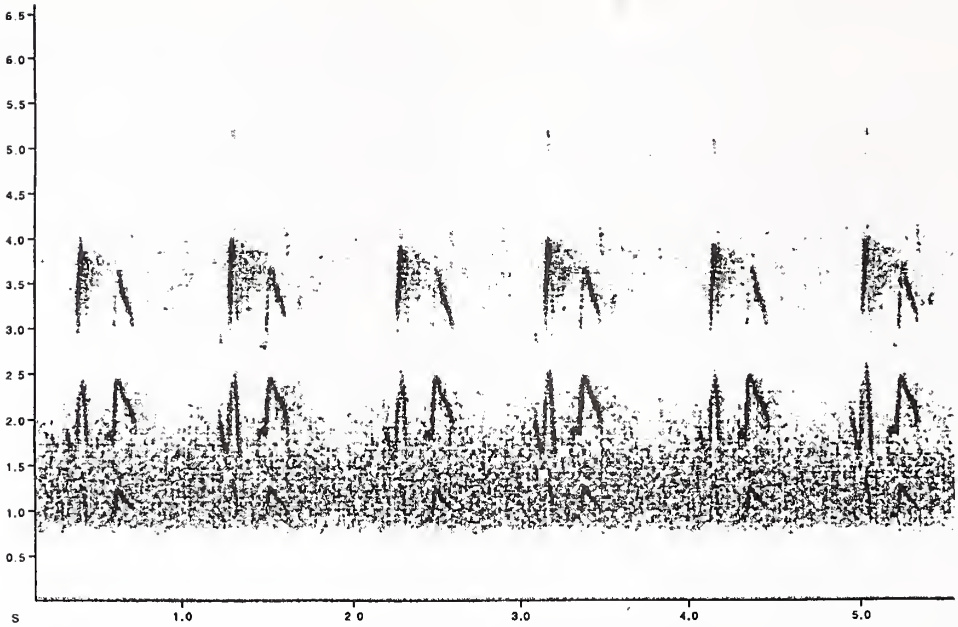

Fig. 2: Spectrogram of a series of six Jerdon's Courser calls. The spectrogram was produced by Canary 1.2.4, grid resolutions 5.8 ms, 10.77 Hz. [Y-axis=kHz, X-axis=S].

help to find the bird in new areas and estimate its population size. It appears that Jerdon's Coursers call mainly at dusk and it may be possible to survey their distribution by listening for the calls. However, initial observations indicate that the short period during which the birds call and the variation among evenings in whether they call at all would make it difficult to survey large areas.

Experiments are in progress using standard playback methods (e.g. Mosher *et al.* 1990; Haug and Diduik 1993) to determine whether tape playback could be used to elicit calls over a longer period. It is hoped to determine the effects of time of the year, time of day and weather on the bird's response to playback.

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THE AFTERMATH OF THE PLEISTOCENE IN THE UPPER NILGIRIS OF SOUTHERN INDIA[1]

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There has been much debate as to why grassy landscapes have persisted in portions of the Nilgiris above 1,200 m. While there is no doubt that firing (especially by the tribal Todas) led to grassland formation and maintenance, we can now conclude with some confidence that climatic changes during the Pleistocene also contributed to the existence of grasslands over long periods. This is confirmed by the results of varied palynological studies (examination of pollen grains) by Blasco, Gupta, Menon, Thanikaimoni, and Vishnu-Mittre in marshy low-lying (= bog) areas within the Upland Nilgiri Island. The most likely, ideal grasslands for continued persistence, probably during the Pleistocene and for possibly millions of years earlier (now, only suggestive), are the high rainfall grasslands of the far western Nilgiris. The harsh climatic controls in these grasslands frequently created environmental conditions in which only grass and not tree species could dominate. The appendices to this paper are designed to help us obtain a greater understanding of the complexity of environmental, cultural, and especially vegetational factors that have endured in the Nilgiris since the Pleistocene ended.

Altogether, they also demonstrate the uniqueness of the Nilgiri Upland Island.

Key words: Upland Island, Pleistocene, Vegetation, Complexity, Grassland, High Rainfall Grassland

Nilgiri Environmental Factors

The region discussed is located where the Western and Eastern Ghats of India converge at their southern ends to form the Nilgiri massif. This mountainous block that is tilted toward the east, with several peaks rising above 2,400 m (8,000 ft), is clearly defined by its precipitous western slopes and the Moyar and Bhavani rivers which flow in fault strike valleys within the lower terrain to the north and south of the block. The Nilgiris form the largest charnokitic mass in southern India and, interestingly, due to the lighter composition of charnokite, are amazing in having far more ancient rock that has risen far above the younger rocks of the plains below. The main focus in this contribution is upon the grasslands which are, or were until contact times when the British first started to live in the upper and cooler climate, in that portion of the region here referred to as the Upland Island lying above 1,200 m. At the start, some consideration is given to different possible causes that may contribute to the presence of grasslands. According to Ranganathan (1938: 523) there is a "wilting effect due to plants exposed to the morning sun being unable to draw water from the frozen soil" as an explanation for why grasses grew together in such stark contrast to the nearby sholas (low canopy evergreen forests) of the upper Nilgiris. Ranganathan reasoned that micro-environments related to the trees within sholas remained above freezing point. Because more energy is radiated out at night on open grasslands, it is particularly at the earth's surface that temperatures might drop below 0 °C. Plants needing to transpire more in response to rapidly increased heating by insolation after sunrise are unable to draw up sufficient moisture due to surface freezing, and thus they wilt. There can be no doubt that fires followed by grazing have also had an impact, as Bor (1938: 608) concluded: "I believe that the shola forest is the relic of an evergreen forest climax which has been pushed back to its last stronghold by fire and grazing. The grassland I consider to be a biotic climax rendered stable by fire and grazing and only one more proof of the stability of grassland under such condition." Among the complex influences upon vegetation which exist in the Nilgiri Upland Island, it seems reasonable to draw a parallel with the treeless balds of the Appalachians in the United States, as conceptualized by Billings and Mark (1957: 140): "The balds are then essentially forest margin or ecotone phenomena existing near the tolerance limits of the principal forest dominants." It is noteworthy that most upper Nilgiri plants are tropical and not temperate in nature, and so we must think of plants spreading upwards into stressful limits. Quite apart from the shock of widespread morning frost and the burning heat of fires, the tolerance limits of upper Nilgiri plant species are severely tried by strong, gusty wind, sometimes over 110 km per hour, heavy rain, drought sometimes prolonged for weeks, exposure to a bright tropical sun that can soon burn the human skin, and cooling from the enfolding, clinging damp mist (the last two sometimes experienced within 30 minutes). Along with the spread of glaciers to lower elevations in the Himalaya during the later Pleistocene (De Terra and Paterson 1939), some evidence is now forthcoming for sufficient climatic change farther south to cause grasslands to form and persist.

Before continuing with vegetative changes during and after the Pleistocene, a comment regarding the writer's use of the term grassland is in order. Blasco and Lengerke (1989: 59-61) use "common savanna" and "high rainfall savanna" instead of grassland, and quite correctly so in terms of their view that grasses on the Nilgiri Upland Island are typically accompanied by a host of herbs and shrubs. While recognizing this fact, the writer prefers to use grassland because, historically, the British colonials did. They also conceptualized grassland by using the term downs, the Nilgiri downs reminding them of open grassy tracts in their homeland. Secondly, considering the original tropical *sabana* of Cuba, from which the word savanna is derived, the more specific use of savanna for a landscape with grasses and scattered trees seems appropriate. While rhododendron and other tree species scattered on Nilgiri grassland form limited savanna areas in that sense, it is the overwhelming presence of low-lying grasses over larger tracts (sometimes over 90% of the terrain) that visually gains the upper hand. Grasses have for long formed a significant part of the vegetation in the Nilgiri Upland Island lying above 1200 m, and that over 10% of the grasses are endemic is suggestive of evolutionary processes that have gone on for millions of years (Appendix 1).

Possible Changes over 40,000 Years

The palynological evidence provided by Vishnu-Mittre and Gupta (1972) and Gupta (1971, 1989), involving bogs and study of pollen grains from soil profiles in a bog at Kakathope on the upper Nilgiris, tentatively suggests the past presence of grasslands — in the above-mentioned sense — over a long period. However, the evidence is tempered by later samplings that indicate a lack of tree pollen accumulation, or even the absence of tree pollen, in sites 1-4 km from the sholas which were investigated. Bera and Gupta (1992: 243) cite i. insect pollination and ii. outer fringe plants preventing the escape of pollen grains as the main factors preventing greater spread of tree pollen. In contrast to a past consensus that grasslands resulted from firing by humans, we can now subscribe to the idea that grasslands have existed far longer, but should be cautioned in our thinking by the realization that sholas have, in all likelihood, simultaneously existed to a greater degree than the pollen record might reveal. A cooler and drier climatic regime probably existed from about 40 to 35,000 years Before the Present (BP), and the evidence indicates that there was widespread grassland on the upper Nilgiris. Along with dominant grass and sedge pollen grains, there was evidence for a variety of herbs and shrubs. It was impossible to identify actual species from the pollen grains gathered from different depths in soil profiles, but plant genera could be identified. Herbs of the genera *Campanula*, *Chenopodium*, *Geranium*, *Justicia* and *Lilium*, shrubs of the genus *Berberis*, and a few sporadic trees of the genera *Ilex* and *Rhododendron* appear to have spread in from the north (Appendix 2). What is even more significant are species that did not move down into the Peninsula from the north. Thus, the oaks (*Quercus*) and pines (*Pinus*) of Meghalaya never managed to spread southward.

Latitudinal variation and insufficient change in climate as a result of glaciation appear to have jointly operated to prevent the spread of other temperate plant species from the north. The species of genera *Berberis*, *Ilex*, and *Rhododendron* that did come are currently hardy, quite capable of surviving as lone sentinels on grassland. Significantly, pollen grains prove that *Strobilanthes* shrubs were also present.

Pollen grains from between 35,000 and 15,000 BP indicate an increase of shrubs and the spread of thickets over grassland. Cool and dry climatic conditions probably persisted, with a shift toward greater aridity. The summer westerly monsoon may have greatly weakened (or not have existed?), and did the easterly monsoon become stronger (Sukumar *et al.* 1993: 704-705)? There was a decline in the pollen grains of grasses and sedges, while those of the Compositae, Dipsacaceae, Leguminosae, Malvaceae, and Rosaceae families, and the genus *Jasminum* (or *Ligustrum* instead?) notably increased. *Strobilanthes* also appears as a dominant group. Pollen grains identified with the genus *Portulaca* were present, but no related species survives today. While pollen grains of the genera *Campanula*, *Geranium*, and *Justicia* declined, those of *Chenopodium* and *Lilium* continued to be present in about the same quantity. The pollen grains of *Berberis*, *Ilex*, and *Rhododendron* are also present, with the last declining as time went by. Among shrubs, there is some evidence of the genus *Sarcococca*, and a better representation of *Lonicera*. Sporadic pollen grains of the genera *Artemisia* and *Impatiens* were also present. Ultimately, there were indications of widespread heaths with some scattered trees. The presence of *Impatiens* pollen grains suggests plant ancestry going back to Madagascar (Appendix 2). There seems some potential of there being grassland over millions of years, as the Indian Peninsula Shield drifted northwards within the Cretaceous to Tertiary periods (between 85 and 30 million years ago), and eventually smashed into the northern continental mass of Laurasia. Along with the high degree of endemism among Nilgiri grasses, a high degree of plant endemism has occurred among the genera *Impatiens* and *Strobilanthes* (Appendix 3). In all of India, it is in the Nilgiris that the greatest evolutionary diversity and multiplicity of species has occurred in these two genera.

The climate probably became warmer and more humid between 15,000 and 7,000 BP. Was there a strengthening of a summer westerly monsoon, eventually somewhat akin to that which now occurs, in this period? There is some evidence for the summer monsoon reaching a peak at about 11,000 BP, and for a progressively drier period to 6,000 BP (Sukumar *et al.* 1993: 705). The greater presence of tree pollen grains in related soil horizons indicates the spread of shola with evergreen tree genera *Elaeocarpus*, *Euonymus*, and *Gordonia*. The spread of sholas also tends to be supported by the marked increase of pollen grains of the genus *Peperomia*, now a common epiphyte in the sholas. It seems unlikely, however, because of a strong continued presence of grass and sedge pollen grains, that the Nilgiri Upland Island was ever covered entirely by sholas.

From about 7,000 BP and continuing into the Post-Contact Era, starting in the early 1820s when the British came, a decline in the pollen grains of shola species indicates a reduction in the areal extent of sholas and an increase in grasslands. There are intervals with a marked decline of *Peperomia* pollen grains, which contrast with a marked increase of *Impatiens* pollen grains. While pollen grains of the genus *Jasminum* (or *Ligustrum*?), so abundant in the earlier heaths, are conspicuously absent, those of the families Compositae, Dipsocaceae, Malvaceae, and the genus *Geranium* are present. In contrast to the earlier heaths, too, there is a lack of *Berberis*, *Ilex*, and *Rhododendron* pollen grains. Might this be due to fires on open grasslands increasingly destroying these genera? Climatic change may, in part at least, be responsible for the increasing shift from sholas to grasslands. A stage to at least 6000 BP, and probably beyond, may be due to increased drying. A weakened westerly monsoon may have again been established by 6000 BP. About 600 BP, and approximately between 1200 and 1400 AD, there appears to have been a warmer and moister period than that which exists at present (Sukumar *et al.* 1993: 705). It is thus, perhaps, no coincidence that there is an abundance of archaeological evidence (partially seen by the author during 1994 field work in the area) for more people living in the Mysore Ditch, just to the north of the Nilgiris, in that period. The possible role of lightning strikes or spontaneous combustion during dry seasons in starting fires and thereby increasing the areal extent of grasslands, leading to an increase of grass pollen grains in Nilgiri waterlogged soils, have not been investigated. Human hunter-gatherers setting fires for millennia might have contributed to shola destruction, *but there is still no archaeological proof of this.*

The Past 3,000 Years

A more conservative time span of 3,000 years provides us with a still more revealing and possibly more accurate glimpse of the past. The pioneering effort of Vimala Menon (1966-1967) is most useful because of its zone-by-zone analysis of a soil profile in a bog at Pykara, west of Ootacamund in the Nilgiris. The profile extends to a depth of 1.7 m and is divided into 15 zones. From zone 1 at the bottom to zone 15 at the top, the percentages of grass pollen grains are: 83, 61, 54, 53, 60, 49 (the lowest), 55, 53, 59, 78, 83, 79, 85 (the highest), 80, and 71. The evidence (count of 2,368 pollen grains) thus indicates a dominance by grasses through most of the period. The spores of ferns are the next largest group (spore count of 340). Although many ferns prefer shadowy, cool and moist environments, suggesting shola, some thrive in shade provided by the rocks and plants of open grassland. We must remember, too, that ferns give off many spores, which can profoundly affect the rate of their accumulation in a soil profile. Sedges (Cyperaceae, pollen count of 159) come next. The following families (with pollen counts) are represented: Liliaceae (123), Compositae (100), Balsaminaceae (96), Scrophulariaceae (63), Xyridaceae (62), Chenopodiaceae (21), Gentianaceae (15), Umbelliferae (12), Cruciferae (12), and Caprifoliaceae (11). These generally indicate the presence of grassland with herbs and shrubs, while pollen grains from trees are conspicuously lacking. The occasional pollen grains of these families probably represent species living in sholas: Araceae, Ericaceae, Euphorbiaceae, Meliaceae, Orchidaceae, Thymeleaceae, and Urticaceae.

Blasco and Thanikaimoni (1974) studied pollen grains from profiles in sediments down to 3.8 m at Pykara and down to 2.1 m at Parson's Valley, south of Pykara. They divided the pollen grains examined into four separate ecological groups: i. herbaceous (grass mainly, but other herbs as well), ii. forest border (forest-grassland ecotone), iii. tree /shrub savanna (trees/shrubs growing on the grassland), and iv. forest (shola). With one exception (decrease of herbaceous pollen grains and increase of forest border pollen grains from the 1.3 to 1.9 m depth at Pykara, into the wetter period c. 600 BP), the graph profiles of herbaceous pollen grains consistently ranged far higher than the graph profiles for the three other groups. Next came the forest border group, then the tree/shrub group, and, lastly, the forest group (Appendix 2). The pollen grains of shola species in the families Celastraceae, Lauraceae, and Myrtaceae were relatively rare, and those of Araliaceae, Elaeocarpaceae, Sapotaceae, Symplocaceae, and the genus *Ilex* were also recorded. While the pollen grains from both places in general ranged from 65 to 80 percent for plants of the open grassland, the pollen grains of forest species were at a low of about 5 percent. Thus, the overall findings parallel those of Menon (1966-67).

Unfortunately, Menon (1966-67) and Blasco and Thanikaimoni (1974) have no radiocarbon dates for any parts of their profiles. However, Blasco and Thanikaimoni (1974) used comparable evidence from the Palnis to devise a dating system. Interpolating with a 1770 AD date for a sample at about 30 cm below the surface and a 1050 BP date for a sample at about 130 cm below the surface in the same locality, they postulate a going back to some 3,000 to 4,000 BP, for layers 3 to 4 m below the surface in the Nilgiris and Palnis. Considering the evidence covered, we are confronted with the possibility of there being extensive natural grasslands on the Nilgiri Upland Island for thousands of years, and more likely for at least the past 3000 years. So strong is the cumulative evidence that we no longer need to primarily use the annual burning of grasslands to explain their presence. There is no denying, however, that the annual burning of grasslands contributed to their spread. While we have no archaeological proof for the burning of grasslands over thousands of years, their seeming presence for so long now raises the possibility of there being humans on the upper Nilgiris far longer than was hitherto proven.

While a characteristic polished Neolithic pointed butt stone implement found in the Mysore Ditch just north of the Nilgiri massif may indicate the presence of humans there by 1000 BC, there is no such indication for the Nilgiri Upland Island. From the evidence yielded thus far from prehistoric sites, among which are the walled stone circles on the tops of peaks, we have no proof of the presence of humans prior to 1 AD (Noble 1989: 127-130). The most logical choice of a people who could have been around for long are the Todas, who are a main element making the Nilgiri Upland Island distinctive. After watching a Toda gather the roots of so-called Toda potatoes (*Ceropegia pusilla* Wt.), eating some of them myself in 1994, and realizing the variety of other foodstuffs which can be gathered, one concludes that Toda ancestors could have been gatherers on the Nilgiri Upland Island and outer slopes. However, ever since 1603, when the priest Yacome Finicio wrote his account of a visit to the Nilgiris, we know that the Todas were buffalo herders from then and into post-contact times (Rivers 1906: 721-730). The historic record shows that they burned the grasslands each year (Appendix 4). Fires set for even 300 years must have contributed to the spread of grasslands, to the detriment of the sholas. We have no idea as to when the distinctive Kota farmers settled on the upper Nilgiris. They are artisans who can still make knives and pots, and there is some potential for their ancestors being the makers of the effigy pots and knives buried at the centre of the stone circles. Ancestors of Badaga farmers, a third distinctive group on the upper Nilgiris and now far outnumbering the other two, probably lived on the upper Nilgiris for centuries before the fall of the Vijayanagar Empire in 1565 AD. Badagas continue a strong tradition of being ruled from Ummatur in Mysore (later absorbed by Karnataka). After the ruler there was overcome by Krishnadevaraya around 1510-1512, a Vijayanagar representative called Wodeyaraya who lived at Konakorai on the upper Nilgiris married the Lingayat Muddu Gowri. At nearby Nedugula, there is still an ancestral temple dedicated to Muddu Gowri (Francis 1908: 333-334, Mulley 1997: 5). While the Badagas used to annually migrate to *hundis* (seasonal livestock stations) in the western Nilgiris, and typically fired nearby grasslands prior to moving back eastward before the onset of westerly monsoon rains, the Kotas to a lesser degree also seasonally occupied grasslands and fired them (Noble 1977). The Forest Department eventually prohibited the annual firing and migration into the grasslands, and these activities for the most part came to an end in the 1960s. The Department also engaged in the planting of trees, and by now black wattle (*Acacia mearnsii* Willd.), blue gum (*Eucalyptus globulus* Labill.) trees, indigenous to Australia, and Mexican pine (*Pinus patula* L.) grow over thousands of hectares once dominated by grasses. By 1987, eucalyptus alone covered about 12,000 ha (Meher-Homji 1987-1988: 159). Mexican pines have typically been planted in frost pockets where the other two species failed.

High Rainfall Sholas and Grasslands

Because the high rainfall sholas and grasslands of the far western Nilgiris are the most ideal candidates for natural grassland occurrence going far back into the Pleistocene, they now receive brief coverage. These little known but ecologically distinctive sholas and grasslands are, for the most part, located in a zone running from a northerly to southerly direction, following the western escarpment, and then, for a shorter distance, the southerly escarpment. Included are the Pandiar cliffs, all the area surrounding Nilgiri Peak, the Mukerti Peak area, the three Western Catchments, Bangitapal Rest

House and adjacent area, areas next to the cliffs in the Nadgani and Sispara areas, and then an area running alongside steep southerly slopes to and somewhat eastward from the Bison Swamp area. These areas have received the highest rainfall in the Indian Peninsula during the westerly monsoon. If we consider the 10,867 mm (424", or 35.3 ft) of rain which fell in Western Catchment Three during 1961, the heaviest rainfall of 713 mm (28") ever recorded in a 24 hour period at Western Catchment Three, on July 7, 1958, and the heaviest rainfall of 1,283 mm (50") ever recorded in a 48-hour period at Mukerti Ridge Top, on July 12 and 13, 1943 (Lengerke 1977: 174, 188; Blasco and Lengerke 1989: 39), we can grasp how unusual these high rainfall areas are.

So harsh is the environment to humans that Toda and Badaga pastoralists made it a regular practice to migrate eastwards, away from the high rainfall and adjacent areas before the westerly monsoon set in. In contrast to the high rainfall and great frequency of clouds, mainly in the period of the westerly monsoon and during the easterly monsoon as well, there are also periods of drought and intense insolation during the year.

In response to the variable and frequently harsh climatic conditions, and associated soils leached by high rainfall, grassland typically dominates. While there are sholas in protected valleys and depressions, high rainfall grasslands sometimes dominate up to both banks of streams and over low-lying terrain. Interestingly, a description by Rao (1974: 214) reveals how some Nilgiri landscapes compare with those in the very high rainfall Cherrapunji area of northeastern India: "...the situation at Cherrapunji, until recently famed as the wettest place on earth, needs special notice. The area looks disappointingly bleak and bare of wooded vegetation, due to the poor soil cover; all the soil being leached out by the heavy rains, leaving behind smooth, bare rocks. For vast distances all around, only dwarf grass growth is visible. It is only in the comparatively sheltered depressions, as at Mamloo and Moswmai, where there is a deposit of soil and humus, that there are small islands of wooded vegetation, in an otherwise vast sea of grassland."

High Rainfall Sholas: According to Blasco and Lengerke (1989: 54-61), high rainfall sholas are composed of a dense growth of trees, often dwarfed, forming a shorter canopy up to *c.*10 m from the ground.

The dominant tree species is often a black plum *Syzygium calophyllifolium* Walp. [trop.]. Other trees, all tropical species, are cinnamon (*Cinnamomum macrocarpum* Hook. and *C. perrottetii* Meissn.), another black plum (*Syzygium densiflorum* Wall. ex. Wt. & Arn.), apple bladder-nut (*Turpinia cochinchinensis* Merr.), white milk tree (*Isonandra perrottetiana* DC.), and mock-olive *(Elaeocarpus recurvatus* Corner). The less frequent Nilgiri magnolia (*Michelia nilagirica* Zenk. [trop.]), spindle (*Euonymus crenulatus* Wall. [temp.]), and cryptocarya (*Cryptocarya lawsoni* Gamb.[trop.]) trees also grow in these sholas. Epiphytes are more common. In addition to a variety of orchids, pepper-elder (*Peperomia reflexa* A. Dietr.) is a very common epiphyte.

As an evolutionary adaptation to the rigorous climatic conditions, two balsams are often epiphytic (*Impatiens orchioides* Bedd. & *laticornis* Fischer) on boulders and trees, whereas one (*neo-barnesii* Fischer) has become a full-fledged epiphyte on trees. It typically grows on branches with moss and pepper-elder, on trees sometimes located above 2400 m and close to or down the western escarpment.

High Rainfall Grasslands: The high rainfall grasslands have *Isachne kunthiana* Miq. and *Themeda triandra* Forsk. grasses. *Arundinella purpurea* Hockst. is the commonest grass in some areas. Among the plants most frequently growing in these grasslands are common anemone (*Anemone rivularis* Ham.), balsams (*Impatiens* spp.), creat (*Andrographis lawsoni* Gamb.), everlasting (*Anaphalis* spp.), kurunji (*Strobilanthes* spp.), Nilgiri privet (*Ligustrum perrottetii* DC), teasel (*Dipsacus leschenaultii* Coult.), wood germander (*Teucrium wightii* Hook.), stunted black plum (*Syzygium* spp.) and rhododendron (basically the *Rhododendron arboreum* Sm. of the Himalaya, now considered subsp. *nilagiricum* (Zenk.) Tagg by Matthew). The high rainfall grasslands offer the ideal habitat for Nilgiri Tahr (*Hemitragus hylocrius* Blyth), animals that prefer living on and close to cliffs. The grasslands are sometimes still burned over in the dry season, despite regulations to the contrary, and it is noteworthy that tahrs relish young grasses that sprout after firing. Thus, they often tend to congregate in such areas. Attempts by the Forest Department to plant trees in high rainfall grasslands have typically ended in failure. Row upon row of dead young plants now stand out on them.

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Appendix 1: A Representative List of Nilgiri Grasses above 1,200 m

Based upon listings in Bor (1960), Sharma *et al.* (1977) (only the Gramineae section), with additional assistance from the Gramineae section in the three Floras: Fyson 1931: 650-681; Gamble 1967: vol 3, 1171-1290 [this section done entirely by C.E.C. Fischer] and Matthew 1999: Pt 3:1442-1604, along with notes made by H.S. Suresh, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

*Endemic; # Most probably introduced

GRAMINEAE (SMALLER GRASSES)

Agrostis peninsularis Hook., 1,800-2,100 m, Kodanad, Nanjanad, Sispara; insufficiently collected and possibly rare, according to Bor.

Agrostis pilosula Trin. var. *filifolia* Bor, 1,800-2,300 m, little known.

Agrostis pilosula Trin. var *pilosula*, 2,000-2,500 m, Doddabetta, Mudimund, Ootacamund, and Sispara.

**Agrostis schmidii* (Hook f.) Bor, 2,400 m, Ootacamund (no specimen in MH).

#*Agrostis stolonifera* L., 2,400 m, Ootacamund; widespread in Europe, Asia, N. America, introduced to the Nilgiris; common, an important fodder grass.

Andropogon lividus Thw., 2,200-2,400 m, purple grass, Kollimund, Mudimund, Ootacamund, Sispara; often in burnt areas, valuable fodder grass.

**Andropogon longipes* Hack., 2,400 m, Ootacamund; hardly known.

**Andropogon polyptychus* Steud. var *deccanensis* Bor, 2,300 m; common perennial around Bison Swamp, in upper Nilgiri marshes, on moister slopes near them; mainly in the far west, the dominating grass in some areas.

#*Anthoxanthum borii* Jain & Pal, 2,000-2,400 m, common, widespread in low-lying ground, especially meadows.

Andropogon odoratum L., 2,400-2,575 m, sweet vernal grass, Doddabetta and Ootacamund; widespread from Europe to temperate Asia, introduced to Nilgiris, sometimes cultivated; has a fragrant odour, can be used as hay, but is not very acceptable to livestock

Apluda mutica L., 1,000-2,400 m, Coonoor, Gudalur, Kundhas, Marappalam-Burliar, Mudumalai, Naduvattam, Ootacamund; common, growing in forests and open country; when young it is good fodder for buffaloes.

#*Aristida adscensionis* L., 850-2,400 m, six-weeks triple awn, Avarihalla R.F., Keti, Ootacamund, Sirur; widely distributed in Old and New Worlds, but probably introduced to Nilgiris; common and widespread except in the wettest of places; eaten by livestock when young, but avoided when in flower.

Arthraxon lanceolatus (Roxb.) Hochst., 2,400 m, Ootacamund; unknown.

Arthraxon quartinianus (A. Rich.) Nash, 1,800-2,400 m, Naduvattam, Ootacamund, Pykara; grows in swampy places, by roadsides, a pioneer on land no longer cultivated; often eaten by livestock.

Arundinella ciliata Nees, 900-2,050 m, Cherambadi, Ebanad, Gudalur-Naduvattam, Kotagiri-Aravenu, Pakasuramalai; on slopes by rocky edges.

Arundinella mesophylla Nees ex Steud., mainly above 1,200 m, Bikkapattimund, widespread, especially east of Doddabetta; on bare slopes by rocky edges.

**Arundinella purpurea* Hochst. var *laxa* Bor, 2,100 m, Sispara, very distinctive and with long pedicels.

**Arundinella purpurea* Hochst. var. *purpurea*, 2,000-2,100 m, Avalanche, Mukerti, Pakasuramalai, Pykara; thus far the only aluminum accumulator known in this family; good fodder grass.

Arundinella setosa Trin. var. *lanifera* Fisch., 1,200-2,400 m., Gudalur Ghat, Naduvattam, Ootacamund, Pykara; a widespread, very variable species, fairly common, good for fodder.

**Arundinella setosa* Trin. var. *nilagiriana* Subbarao et Kumari, 1,850 m, at Koilbetta, near Ebanad; like *A. s.* var. *lanifera*, but has hirsute glumes instead.

Arundinella vaginata Bor, 600 to 2,100m, with long, villous, basal sheaths; sometimes abundant, on grassy slopes, in marshes.

Arundo conspicua Forst., 2,400 m, Ootacamund; virtually unknown.

#*Avena sativa* L., 2,200 m, Nanjanad; oats introduced from Europe, first a weed there alongside barley and wheat, then domesticated around 1,000 BC; now marginally cultivated in the Nilgiris and often a weed.

#*Avena sterilis* L., 2,400 m, Ootacamund; seldom cultivated, and mainly a weed introduced from the Mediterranean.

#*Axonopus affinis* Chase, 1,000-1,660 m, Coonoor Ghat, Ouchterlony Valley; carpet grass introduced from the New World, excellent for fodder.

Bothriochloa bladhii Retz, 2,400 m, Ootacamund; somewhat coarse and good for fodder.

Bothriochloa foulkesii Henr., 1,900-2,400 m, Mudimund, Ootacamund, Porthimund, Pykara; near water and in marshes.

#*Bothriochloa insculpta* A. Camus, 1,650-2,400 m, Kateri Falls, Naduvattam, Ootacamund, Pakasaramalai, Pykara; common on downs; from tropical East Africa, it now grows over the Western Ghats and is used for fodder.

Brachiaria semiundulata Stapf, 1,200-2,00 m, Coonoor, Naduvattam, Nanjanad, Ootacamund, Ouchterlony Valley, Pykara; common, on exposed slopes, with large glabrous spikelets.

#*Brachypodium sylvaticum* P. Beauv., 1,800-2,400 m, perennial slender grass, Coonoor, Naduvattam, Ootacamund, Pakasuramalai, Pykara; grows in Europe and on temperate mountains in tropical Asia, but was probably introduced to the Nilgiris.

#*Briza maxima* L., 1,800-2,500 m, large quaking grass, Doddabetta, Naduvattam, Ootacamund, Pykara, Upper Bhavani; common, from the Mediterranean, but an escape.

#*Briza minor* L., 1,800-2,400 m, small quaking grass, Coonoor, Naduvattam, Ootacamund, Pykara; common, also introduced from the Mediterranean.

#*Bromus arvensis* L., 2,400 m, Ootacamund; Hubbard — cultivated for hay on poor soils in Europe; introduced to the Nilgiris and now growing wild.

# *Bromus catharticus* Vahl., 1,900-2,400 m, Coonoor, Ootacamund, Upper Tiger Shola; native to South America, introduced as a fodder grass, but now a common escape.

# *Bromus ramosus* Huds., 1,900-2,400 m, Ootacamund and Pykara; common from Europe into mountains of Central Asia, but was probably introduced into the Nilgiris; grows in shola glades and shady places.

Capillipedium huegelii Stapf, 1,200-1,800 m, Kariashola, Naduvattam, Sundapatti; common annual or perennial, wide ranging, often aromatic.

Chrysopogon hackelii Fischer, 1,000-1,800 m, Gudalur-Nadugani, Naduvattam; a common, robust grass of mountainous areas.

Chrysopogon orientalis A. Camus, 1,000-1,800 m, Ebanad, Gudalur, Naduvattam; common, conspicuous owing to its bright red and purple glumes, eaten by livestock.

Chrysopogon verticillatus Trin., mainly above 1,200 m, in mountains of Tamil Nadu and Orissa; stout, hardly acceptable to livestock when fully grown, but commonly eaten when young.

Chrysopogon zeylanicus Thw., 1,800-2,400 m, Aravankadu, Avarihalla R. F., Kotagiri, Naduvattam, Ootacamund, Pakasuramalai, Parkside R.F., Pykara, Sispara; large, with green and purple spikelets, widespread and common on the downs, higher peaks.

Coelachne perpusilla Thw., 2,300 m, Porthimund, may be common; very delicate and trailing marshland lover.

#*Cortaderia selloana* Asch. & Graebn., 2,400 m, Pampas grass, Ootacamund; an ornamental from South America.

Cymbopogon flexuosus Wats. var. *flexuosus* Bor, 700-2,400 m, Burliar, Coonoor, Gudalur-Naduvattam, Mudumalai, Ootacamund, Pakasuramalai, Pykara; common tall (1.5m) perennial, the source of lemon grass oil, sometimes cultivated.

Cymbopogon martinii Wats., 1,900 m and below, geranium grass, Pykara; a common perennial, sometimes cultivated for rusa oil in two forms: 1) motia, palmarusa oil and 2) sofia, ginger grass oil.

Cymbopogon nardus Rendle var. *confertiflorus* Stapf ex Bor, 800-1,500 m, tall (1.5 m) wild citronella grass, sometimes cultivated; mainly on outer eastern Nilgiri slopes, sometimes dominating on savannas.

Cymbopogon polyneuros Stapf, 1,900-2,500 m, Doddabetta, Mukurti, Ootacamund, Pykara; also tall (1.5m), with oil having a pleasant odour, but not used commercially.

Cynodon dactylon Pers., 1,400-1,900 m, Bermuda or dog's tooth grass, now worldwide and a troublesome weed in more than 80 countries; Ebanad, Ouchterlony Valley, and Pykara; a common perennial creeping grass, highly nutritious, especially for horses; as a lawn grass it can withstand only moderate grazing.

Cyrtococcum deccanense Bor, 1,600-1,700 m, Coonoor, Gudalur Ghat, Kateri Falls; loves damp places, grows well in shade.

Cyrtococcum longipes A. Camus, 800-1,800 m, Carcoor Ghat and Naduvattam; in damp and shady places.

# *Cyrtococcum patens* A. Camus, 800-2,050 m, Pakasuramalai and Segur; widespread in Southeast Asia, probably introduced to the Nilgiris.

#*Dactylis glomerata* L., 2,100-2,400 m, only species in the genus, Nanjanad and Ootacamund; perennial grass in North Africa, Europe, and temperate Asia; introduced, important fodder grass on Government hill farms, now a common escape

Dichanthium oliganthum (Steud.) Cope, 1,900-2,100 m, Avalanche, Bikkapattimund, Mudimund, Naduvattam, Pykara, Sispara; widespread, roadsides, grassy slopes; whole plant villous, with a very aromatic and volatile scent.

**Dichanthium pallidum* (Hook f.) Stapf ex Fisch., elevational factors unknown, rare and collected by Foulkes (no specimen in MH).

Digitaria ciliaris Koel., 850-2,100 m, Anaikatti, Benne R.F., Deepdale R.F, Gudalur, Nanjanad, Northern Hay R.F., Pakasuramalai, Sirur-Ebanad; pan-Tropical weed, common, good fodder grass, alongside roads and on open ground.

Digitaria longiflora Pers., 1,000-2,000 m, Aravankadu, Gudalur, Kunnacombai R.F., Pakasuramalai; another pan-Tropical weed, common creeping grass alongside roads and in open spaces, often eaten by livestock.

Digitaria ternata Stapf, 2,100-2,400 m, Nanjanad and Ootacamund; in the wild from Africa to the Far East, common in wastelands, but with little fodder value; a handsome grass with silver racemes and purple fruits.

Digitaria wallichiana Stapf, 1,200-2,200 m, Gudalur Ghat, Kunnacombai R.F., Naduvattam, Ootacamund, Pakasuramalai; commonly eaten by livestock.

#*Ehrharta abyssinica* Hochst., introduced from Africa, collected by Schmidt in about 1830; little is known about it in the Nilgiris.

#*Eleusine coracana* Gaertn., 1,200-1,900 m, still grown widely by the Badagas finger millet cultivated in Africa for over 5000 years and introduced to India about 3000 years ago; harvested grain stores well for a long time, stalks also provide hay for livestock.

Eleusine indica Gaertn., 1,000-2,000 m, Mudumalai and Parkside R.F.; spread from India and now a noxious weed worldwide; annual, rapidly colonizing open spaces, and thus a good soil binder.

Eragrostis gangetica Steud., 850-2,400 m, Anaikatty, Coonoor, Kilkotagiri, Kotagiri, Kunnucombai, Naduvattam, Ootacamund, Pakasuramalai, Parkside R.F., Segur; common annual also spreading in stream beds, eaten by cattle but not good for fodder.

Eragrostis nigra Nees ex Steud., 1,550-2,575 m, Carrington-Kinnakorai, Coonoor, Doddabetta, Kunnacombai R.F., Naduvattam, Ootacamund, Pykara, Sirur-Ebanad, Upper Bhavani; widely common, growing on exposed rocks and in wastelands.

Eragrostis pilosa P. Beauv., 1,800-2,400 m, hairy or Indian love grass, Naduvattam, Ootacamund; common, grazed in some areas but rejected by livestock in others.

Eragrostis tenuifolia Hochst. ex Steud., 1000-2400 m, Gudalur, Kunnacombai R.F., Ootacamund, Pykara; common weed, seeking fallow earth.

Eragrostis unioloides Nees ex Steud., 950-2,400 m, Avalanche, Bikkapattimund, Bokkapuram R.F., Coonoor, Ebanad, Gudalur Ghat, Kunnacombai, Mudamalai, Nanjanad, Naduvattam, Ootacamund, Pakasuramalai; common and widely distributed, sometimes growing in water or damp places.

**Eriochrysis rangacharii* Fisch., at 1,830 m, fairly common near Pykara; only Indian representative of an otherwise wholly tropical African and American genus.

Eulalia phaeothrix O. Ktze., 1,500-2,200 m, Kotagiri, Mudimund, Pakasuramalai, Pykara, Sirur-Ebanad; common on the downs, sometimes a dominant.

Festuca ovina L., 2,400-2,575 m, sheep's fescue, Doddabetta, Ootacamund; worldwide temperate and tropical mountains; a hardy and wiry grass relished by sheep.

Garnotia arundinacea Hook., 1,000-1,900 m, Balmadies Estate, Coonoor, Gudalur, Kateri Falls, Naduvattam, Upper Tiger Shola; trailing grass fond of shady places.

Gamotia courtallensis Thw., 1,500 m and above, Adderly Estate; common, in shady woods and nullahs (valleys), on moist ground or attached to rocks.

Gamotia schmidii Hook., 1,400 m, little known perennial with flattened leaf sheaths.

#*Glyceria spicata* Guss., 1,650-2,400 m, Kateri Falls, Nanjanad, Ootacamund; from the Mediterranean and now wild; floating meadow grass, thus seeking wet areas.

Helictotrichon asperum Bor, 1,800-2,500 m, Doddabetta, Kodanad, Mudimund, Naduvattam, Ootacamund, Pykara; common and widespread.

**Helictotrichon polyneurum* (Hook.) Henr., 2,400 m, Doddabetta (Gamble 12993); fairly common, a distinctive looking grass.

Heteropogon contortus P. Beauv., 910-2,400 m, spear grass, Avarihalla R.F., Kodanad-Kotagiri, Ootacamund, Sirur-Ebanad; common, widespread, colonising in wasteland and on the downs, grazed upon when young.

#*Hordeum vulgare* L., mostly above 1,700 m, barley, once widely grown by the Badagas but now very limited in its cultivation. Cultivated in the Middle East before 6000 BC and spread in India after 3000 BC.

Isachne bourneorum Fischer, 1,200-2,500 m, Doddabetta, Gudalur Ghat, Naduvattam; endemic to the Western Ghats; in sholas, rock crevices, on bare slopes.

Isachne deccanensis Bor, 2,440 m, on downs near Ootacamund (no specimen in MH); endemic to the Nilgiris and Palnis.

Isachne elegans Dalz., 1,500-2,400 m, Ootacamund; possibly rare in the Nilgiris, in marshes and moist places.

Isachne globosa Kuntze, 1,000-2,025 m, Coonoor, Ebanad-Anaikatty, Gudalur, Kottaicombai, Pykara; common grass in wet places, gregarious in marshes, readily grazed by livestock; also a troublesome weed in rice fields at lower elevations.

Isachne kunthiana Miq. var. *kunthiana* Bor, 1,900-2,500 m, Avalanche, Doddabetta, Mudimund Kothaban R.F., Ootacamund, Pakasuramalai, Pykara, common in high south Indian marshes.

Isachne kunthiana Miq. var. *latifolia* Hook., 1800-2400 m, Avalanche, Naduvattam, Ootacamund; also common in high altitude marshes.

**Isachne oreades* (Domin) Bor, close to 1,200 m, only in the Gudalur Ghat area, recorded in a swamp within shola.

Isachne walkeri Wight & Arn., 1,800-2,025 m, Carrington-Kinnakorai, Coonoor, Pakasuramalai; a tall perennial grass, common in high Nilgiris.

Ischaemum commutatum Hack., 1,800-2,400 m, Coonoor, Naduvattam, Nanjanad, Ootacamund, Pykara; widely distributed, growing on stream banks and on steep slopes.

Ischaemum indicum Merrill var. *indicum*, 1,000-2,400 m, Bikkatti, Ebanad-Anaikatty, Mudumalai, Kunnacombai-Kundah, Ootacamund, Pakasuramalai, Pykara; sometimes the most common grass on open downs.

Ischaemum nilagiricum Hack., 950-2,000 m, Coonoor, Gudalur-Nadugani, Kalhatti, Kolikarai, Northern Hay R.F., Runneymede, Sirur-Kukkal; often by streams.

Ischaemum timorense Kunth, 700-1,500 m, Gudalur Ghat, in damp places and eaten by livestock.

Jansenella griffithiana Bor, 1,600 m, only species in this genus of India-Burma (Myanmar), Naduvattam; common, on marshes, stream banks, grassy peaks, grazed by livestock.

Leersia hexandra Sw., 2,400 m and far below, throughout Tropics, Ootacamund; common perennial in a variety of moist habitats, often forming extensive colonies; eaten by cattle and buffaloes.

#*Lolium perenne* L., 2,400 m, introduced worldwide and to Ootacamund; widespread naturally from Europe to temperate Asia, cultivated perennial rye grass and now an escape; valued for grazing and hay, but can be poisonous when infected by fungi.

#*Lolium temulentum* L., 2,100 m, Nanjanad; genetically developed introduction native to the Mediterranean, now an escape; a weed in cultivated areas, its seeds when infected with a fungus can poison livestock.

#*Miscanthus nepalensis* Hack., 2,000-2,400 m, Keti, Ootacamund; introduced from the Himalaya or northeast India; a tall ornamental perennial.

Oplismenus compositus P. Beauv., 1,100-2,400 m, Gudalur Ghat, Naduvattam, Nonesuch Estate, Ootacamund, Pakasuramalai, Sirur-Ebanad; perennial, common in moist places within sholas, sometimes in gregarious patches.

Oplismenus undulatifolius P. Beauv., 1,875-2,400 m, Avalanche, Ootacamund, T. R. Bazaar; a shola grass.

Panicum gardneri Thw., 1,000-2,025 m, Carriot shola, Coonoor, Naduvattam, Sholurmattam; common in sholas, a silvery hyaline margin of glumes and lower lemma is diagnostic.

#*Panicum maximum* Jacq., 2000-2400 m, Guinea grass, Bengalmattam, Ootacamund; from Africa; commonly cultivated for fodder, an occasional escape.

#*Panicum repens* L., 1,900-2,00 m, Coonoor, Manjanakora, Ootacamund, Pakasuramalai, Pykara; torpedo grass throughout tropics and subtropics and one of the most widely distributed grasses in the world, in all kinds of habitats, but prefers perennially moist places; sometimes a pest in cultivated fields.

#*Panicum sumatrense* Roth et Schult., straddling 1,200 m, once cultivated widely by the Badagas for grain and fodder, but now in great decline; little millet, once identified as *miliare* Lam., progenitor a mystery, was a very ancient cultivar from China into Europe.

Paspalum canarae Steud., 1,800 m, Naduvattam; common annual, in sandy, moist places.

#*Paspalum dilatatum* Poir, 1,800-2,400 m, Dallis grass, Carrington, Coonoor, Naduvattam, Ootacamund; introduced from South America; an excellent pasture grass, important for fodder, can withstand grazing and moderate frost.

#*Paspalum scrobiculatum* L., 600-1,900 m, Pakasuramalai, Pykara, lower eastern and southern slopes; koda or kodra millet, common wild perennial throughout India to 1,600 m, is seldom cultivated now; as a cultivar, seen only among the Kurumbas; often grows wild in wasteland and moist places, grazed by livestock; seedheads liable to ergot infection, making them poisonous.

#*Pennisetum clandestinum* Hochst., 2,100-2,400 m, Kikuyu grass, Nanjanad, Ootacamund; introduced from eastern Africa in 1926; vigorous, stoloniferous growth; good pasture and fodder grass, used for lawns and as a soil binder on slopes; now a widespread escape.

#*Pennisetum villosum* R. Br., 2,400 m, Ootacamund; introduced from the Middle East, now growing wild as well; frequently raised as an ornamental.

#*Phalaris aquatica* Cent., 2,400 m, Ootacamund; native to the Mediterranean, but introduced and cultivated as a pasture grass.

Poa annua L., 1,900-2,400 m, annual meadow grass, Aravenu, Coonoor, Keti, Nanjanad, Ootacamund; fairly common, growing widely in India at higher elevations.

**Poa gamblei* Bor, above 2,500 m, and therefore on the highest peaks; fairly common.

#*Rhynchelytrum repens* C. E. Hubb., 1,450 m, Kateri-Kundah; native of tropical Africa, introduced to gardens and now an escape; not a fodder grass.

Rottboellia exaltata L., 1,675m, Sirur-Kukalthorai; widely distributed annual, in moist places, provides hay.

Sacciolepis indica A. Chase, 1,650-1,925 m, Avalanche, Ebanad-Sirur; Kateri Falls, Keti, Kodanad; common grass in marshy places, sometimes up to 1 m tall.

Sehima nervosum Stapf, 1,850 m, Ebanad; locally common perennial grass, in dry, sandy, rocky places; good for fodder.

Setaria glauca (L.) P. Beauv., 1,000-2,400 m, Anaikatty, Benne R.F., Devarshola, Doddabetta, Edapalli, Kottaicombai, Kunnacombai R.F., Mudumalai, Mukerti, Ootacamund, Pakasuramalai, Pykara, Sirur-Kukkal; fairly common, widely distributed, an acceptable fodder grass.

# *Setaria italica* (L.) P. Beauv., mostly above 1,100 m, once widely cultivated by the Badagas but now in great decline; foxtail millet, progenitor not firmly established, a sacred plant in China by 2,700 BC, and a very early cultivar over a vast region into Europe.

Setaria tomentosa Kunth., 950-2,010 m, Gudalur Ghat, Kundah, Kunnacombai, Kunjapanai, Northern Hay R.F.; widespread in the plains; at higher elevations in ditches near roads, mostly in moist and shady places.

Sporobolus diander (Retz.) P. Beauv., 1,000-2,400 m, Benne R.F., Carrington, Coonoor, Gudalur, Mudumalai, Ootacamund; good pasture grass.

Sporobolus piliferus Kunth, 1,900 m and lower, Bikkapattimund, Coonoor; often colonises broken ground and is grazed by livestock.

Themeda quadrivalvis O. Ktze. var. *quadrivalvis*, 1,500-2,400 m, Anaikatty-Ebanad, Ootacamund; widely distributed, preferred by buffaloes.

Themeda trianda Forsk., 1,000-2,400 m, widespread in grassy areas, very common perennial in the Old World tropics and subtropics; good for grazing livestock when young.

Tripogon bromoides Roem. & Schult., 1,600-2,400 m; common on rocky surfaces, walls, and in crevices.

Tripogon capillatus Jaub. & Spach, 900-1,300 m, widespread in the Western Ghats; often epiphytic amidst the mosses of shola trees and on old walls.

Tripogon jacquemontii Stapf, 2,200-2,600 m, Coonoor Peak and higher; often gregarious, in barren places.

Tripogon wightii Hook., 1,000-1,800 m, endemic to southern India.

#*Triticum* spp. 1,200-2,200 m, once widely cultivated and now rarely so; wheat greatly in need of study, with varieties introduced by the British; domesticated by 6,500 BC in the Middle East.

#*Vulpia megalura* Rydb., 2,400 m, North American grass, now growing near Ootacamund.

#*Vulpia myuros* Gmel., 2,000-2,500 m, mouse-tailed fescue, Doddabetta, Keti, Nanjanad, Ootacamund, Pykara, Upper Bhavani; widespread from Europe into temperate Asia; introduced, now runs wild and grows as a weed in cultivated areas.

Zenkeria elegans Trin., 1,700-1,930 m, Aravenu-Kotagiri, Bokkapuram R.F., Coonoor, Kodanad R.F., Mandalore R.F.; little known perennial, widespread in southern India; first recorded for the Nilgiris by Gamble.

Zenkeria stapfii Henr., above 1,200 m, southern India and Sri Lanka; earliest record in the Nilgiris by Perrottet and little known there.

Appendix 2: Nilgiri Plants in their International (Generic) and Local (Species) Environmental Settings

The following lists are greatly modified revisions based upon nuclear data and organization in Blasco and Thanikaimoni (1974), Gupta (1971, 1989), Mani (1974), Meher-Homji (1967, 1975), Menon (1966-67), Shankarnarayan (1958), and Vishnu-Mittre and Gupta (1972). The floras by Fyson (1932), Gamble (1967), Mathew (1999), and Sharma *et al.* (1977) were constantly referred to. The international distributions of plant genera were found in Shaw and Willis (1973). There was no attempt to make the lists complete, but an effort was made to cover representative families and genera of plants of the Nilgiris. Different groups of plants focused upon in suggestive listings enable us to consider how the overall vegetation of the Nilgiri upland island has varied through time, and to think about the significance of specific plants in the region. Because they play such a significant role in making the Nilgiris botanically distinctive, there is more coverage of the balsam, orchid and strobilanthes plants.

Note: *The number within parentheses following the genus represents the number of species of that genus being covered.*

NON-GRASS SPECIES ON GRASSLAND

Some plants and their ancestors probably spread in during the Pleistocene:

ACANTHACEAE

Justicia (300, tropics and subtropics): *latispica, nilgherrensis, simplex,* herbs growing widely in Indo-Malaya and Ethiopia, common in open grassland of the downs.

BUXACEAE

Sarcococca (about 20, Himalaya to China, Taiwan, and the Philippines): *trinervia*, shrub, very common all over the downs, also on Eastern Ghats.

CAMPANULACEAE

Campanula (300, North Hemisphere, temperate, especially the Mediterranean and tropical mountains): *fulgens*, herb, also in Khasi Hills, Nepal, Sikkim.

CAPRIFOLIACEAE

Lonicera (200, North America, Eurasia, Africa, Himalaya, to Malaysia and the Philippines): *ligustrina*, untidy shrub, also in Nepal, Khasi Hills.

CARYOPHYLLACEAE

Stellaria (120, cosmopolitan): *media* and *saxatilis*, herbs, now common weeds, on grasslands as well.

CHENOPODIACEAE

Chenopodium (about 150, temperate parts of the world): *ambrosioides*, erect or prostrate herb, a common weed, Nilgiris and Shevaroys.

COMPOSITAE

Artemisia (400, mainly in temperate Northern Hemisphere, common in northeast China, western US and on Russian steppes; South Africa, South America): *vulgaris*, tall aromatic herb, shrub, South Indian mountains to Himalaya; apparently truly wild in Nilgiris though commonly cultivated.

Cnicus (about 150, mostly in northern temperate climates): *wallichii*, Common Indian Thistle with stem over 1 m high, open downs, flowers in June, from Himalaya — Nepal, Sikkim and Bhutan.

Senecio (up to 3000, cosmopolitan, varied: climbers, xerophytes, succulents, herbs, shrubs, to trees): *corymbosus*, climber on downs; *lavandulaefolius*, herb on open downs; *wighti*, swamp ragwort, also growing in Khasi Hills.

CRUCIFERAE

Cardamine (160, cosmopolitan, but chiefly temperate): *hirsuta*, Hairy Bitter-cress, annual herb, common on the downs, generally in all temperate Eurasian countries, including England, and all temperate parts of India.

CYPERACEAE

Carex (up to 2000, cosmopolitan, especially in temperate parts of the world, with many alpine and marsh dwelling species): *lindleyana*, herb, sedge, on exposed dry land, Sri Lanka to Khasi Hills, China, Japan; *nubigena*, another sedge, in damp places, not in water, widespread, Malaya, China, Japan, Sri Lanka, Western Ghats to Khasi Hills, Himalaya.

DIPSACACEAE

Dipsacus (86, in Eurasia, especially in the Mediterranean, tropical Africa): *leschenaultii*, teasel, a large herb on the downs.

DROSERACEAE

Drosera (100, tropical and temperate, especially Australia and New Zealand), with enfolding sticky leaves enabling plants to ingest trapped insects): *burmanii*, Common Sundew, all India, tiny herb in damp places, widespread in Nilgiris; *peltata*, moon-leaf sundew, all India, tiny herb, everywhere on damp Nilgiri downs.

ERIOCAULACEAE

Eriocaulon (400, tropical and subtropical, *c.* 30 in Japan and *c.* 8 in North America, with *septangulare* in eastern US and the Scottish Hebrides): *collinum*, Hat-pin Flower or small grey-head, small herb, common in wet places, South India and Sri Lanka.

GENTIANACEAE

Exacum (40, palaeotropical, at least 20 in India): *perrottetii* and *wightianum*, both herbs.

Gentiana (400, cosmopolitan, excluding Africa, chiefly alpine): *pedicellata*, common herb on Nilgiri downs, also in Himalaya (Kashmir to Bhutan), Khasi Hills to Java and China.

GERANIACEAE

Geranium (400, cosmopolitan, especially temperate parts of the world): *nepalense*, Crane's Bill, common herb on downs, Kashmir, Himalaya and Khasi Hills.

GUTTIFERAE

Hypericum (400, in tropical and temperate mountains): *mysorense*, St. John's Wort, shrub on grasslands, abundant everywhere on the downs, especially on poorer soils, sometimes covering entire slopes, only in South Indian mountains.

HAEMODORACEAE

Ophiopogon (20, Himalaya to Japan and Philippines): *intermedius* [founded on a Nepal plant and indistinguishable from it?], Lily of the Wood, herb, at lower levels, Kotagari included, Western Ghats, Himalaya and Khasi Hills.

HYPOXIDACEAE

Curculigo (10, tropical up into temperate mountain regions): *orchioides*, Yellow Ground Star, small perennial herb in moist places, Himalaya, Khasi Hills and Western Ghats.

Hypoxis (100, Africa, Indo-Malaya, East Asia, Australia, America): *aurea*, small herb scattered in grasslands, Kashmir to South India, Java, China and Japan.

Molineria (7, Indo-Malaya): *trichocarpa*, another small herb, common on the higher downs, especially in loosened soil areas.

LABIATAE

Micromeria (100, cosmopolitan): *biflora*, Lemon-scented Thyme, herb, common over higher grassy slopes, Himalaya, Kashmir to Bhutan and on higher mountains of South India; *capitellata*, has taller stem and larger leaves, western Himalaya to mountains of South India.

Teucrium (300, cosmopolitan, but especially the Mediterranean): *wightii*, thick stemmed herb in rocky places on higher downs.

LENTIBULARIACEAE

Utricularia (120, tropical and temperate regions, all in the latter being aquatic; many species remarkable for small bladders which trap and then enable digestion of small creatures): *graminifolia*, Common Blue Bladderwort; *scandens*, Yellow Bladderwort, both common small herbs in marshes within the downs.

LILIACEAE

Lilium (80, mainly in northern temperate regions): *neilgherrense*, the Nilgiri Lily, once common on downs, stems to 1 m, white flowers, only in extreme southern India — Anamalai, Biligirirangan, Nilgiri, Palni and Tinnevelly Hills.

LOBELIACEAE

Lobelia (about 250, cosmopolitan, mostly tropical and subtropical, especially America; giant lobelias in Africa and Asia): *leschenaultiana*, giant lobelia, biennial subshrub with pale yellow flowers, common everywhere, higher grasslands as well, but also in shola fringes; Sri Lanka, Indian Peninsula into Southeast Asia.

OLEACEAE

Ligustrum (about 50, Europe to northern Iran, East Asia, Indo-Malaya to New Guinea and Australia): *perrottetii*, privet, usually a shrub but a tree in eastern areas, in clumps on the western downs, doing well near water.

ORCHIDACEAE

The international distributions of the genera in this section are provided later under Shola Species.

Aerides crispum, an epiphyte in sholas, especially near Coonoor, called the Pink Rock Orchid because it is so often seen growing on exposed rocks, Western Ghats, Palnis as well.

Habenaria cephalotes, *heyneana*, and *longicorniculata*, ground orchids amidst grasses.

Peristylus richardianus and *spiralis*, ground orchids, widespread on grasslands.

Satyrium nepalense, ground orchid, on grasslands and in marshes, abundant during westerly monsoon; widespread from Sri Lanka northward to the Himalaya and east into Burma.

Spiranthes sinensis, Lady's Tresses, terrestrial orchid, on open dry grasslands and in swamps; *sinensis* var. *wightiana*, especially in the Kotagiri area.

PAPILIONACEAE

Crotalaria (550, 100 undescribed?, at least 80 in India, tropics and subtropics, variable — procumbent creepers, to erect herbs, to shrubs and trees), genus named after the way seeds rattle in ripened pods [Gk. *krotalon* = a child's rattle]; on the higher downs, these species are liable to be encountered with attractive yellow flowers: *leschenaultii*, small bush with long flower spikes; *scabrella*, procumbent herb to shrub with flower spikes; *wightiana*, bushy shrub with rising flower spikes.

Indigofera (700, warm parts of the world, but especially South Africa): *cassioides*, shrub on open downs; *pedicellata*, common prostrate herb on higher downs; both species in Peninsula mountains, including the Western Ghats.

Sophora (50, tropical and warm temperate regions): *glauca*, shrub on downs, and especially on drier hillsides; mountains of South India, but not in the Palnis or Maharashtra State.

POLYGALACEAE

Polygala (about 550, cosmopolitan, excluding New Zealand, Polynesia and the Arctic): *sibirica*, milkwort, a common herb on the higher downs, sometimes dominant, Mudimund and Ootacamund; Himalaya, Kashmir eastward to Khasi Hills, China, Siberia and Japan.

PORTULACACEAE

Portulaca (200, tropics and subtropics): in Nilgiris(?), none now.

PRIMULACEAE

Lysimachia (200, cosmopolitan, especially East Asia and North America): *candida* subsp. *obovata*, a slender herb amidst grasses; *deltoides*, in Kundah grasslands; *leschenaultii*, small perennial herb, on higher downs, prefers open marshy meadows; *procumbens*, creeping Jenny, a trailing herb, closely allied to a European species.

RANUNCULACEAE

Anemone (150, cosmopolitan): *rivularis*, a perennial herb, all over the Nilgiris, luxurious in damp places and dwarfed with dryness, to 4,000 m in Sikkim.

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *reniformis*, a common perennial herb in damp places on open downs, showy bright yellow flowers, only in mountains of south India.

RHAMNACEAE

Rhamnus (110, cosmopolitan): *virgatus*, Indian Buckthorn, spiny and stunted shrub, uncommon in upper Nilgiris; in temperate Himalaya and from China to Japan.

ROSACEAE

Cotoneaster (50, mainly North Hemisphere, temperate regions): *buxifolia*, small tree to shrub, hard and tough wood, sometimes amidst grasses; in Western Ghats and Palnis.

Potentilla (500, nearly cosmopolitan, but mostly in Northern Hemisphere, temperate to Arctic areas): *leschenaultiana*, herb, yellow flowers, common in open grassland; *sundaica*, herb, bright yellow flowers, higher grasslands, especially in moist areas.

Rosa (250, Northern Hemisphere, temperate realms and tropical mountains): *leschenaultiana*, Nilgiri Dog Rose, abundant and often found in shola fringes as well.

Rubus (250, cosmopolitan, especially in temperate areas of Northern Hemisphere, with about 3000 segregates and forms of *fruticosus*, the Blackberry): *ellipticus*, Yellow Raspberry, in Western Ghats but not Maharashtra, also in temperate - tropical Himalaya, Khasi Hills, Burma and Yunan; *rugosus*, Purple Raspberry, rare on Bombay Ghats, but in Himalaya, Nepal, Sikkim, Burma and Malaya; both species widespread on downs and in shola borders.

SANTALACEAE

Osyris (6 or 7, Mediterranean and Africa to India): *wightiana*, evergreen shrub on open downs and in sholas, only in higher mountains of India and Sri Lanka.

Thesium (325, Europe, Africa and Asia to Australia): *wightianum*, yellow procumbent perennial herb, parasitic on roots of other plants, common in higher grasslands.

SCROPHULARIACEAE

Pedicularis (500, mostly Northern Hemisphere, especially in mountains of Central and East Asia): *perrottetii*, Nilgiri Lousewort, perennial herb, remarkable for its large white flowers to 10 cm, mainly in the Kundah grasslands, seen in the vicinity of Avalanche, Mukerti and Nilgiri peaks, also in the Anamalais, not the Palnis; *zeylanica*, Pink Rattle, perennial herb, semi-parasitic, red flowers, in damp places on higher grasslands, near Kotagiri and Ootacamund, only in Sri Lanka and South India mountains, Palnis included.

SOLANACEAE

Solanum (1,700, tropical and temperate regions): *violaceum* subsp. *multiflorum*, prickly low bush, common on the downs, from Ootacamund to Pykara; *wightii*, erect herbaceous plant with large lavender blue flowers, easily seen near Coonoor, also living up to higher downs.

UMBELLIFERAE

Bupleurum (150, Europe, Asia, Africa, and North America): *distichophyllum*, short herb, grass-like, common on higher downs; *mucronatum*, common hare's ear, stout, branched herb, also over downs; *plantaginifolium*, Giant Hare's Ear, tall perennial herb to over 1 m high, only in mountains of South India, on Doddabetta, Elk Hill and Snowdon.

Heracleum (70, temperate areas in Northern Hemisphere and tropical mountains): *candolleanum*, large leafy herb, common on higher grasslands; *ceylanicum*, tall herb, attractive Queen Anne's lace with white flowers, in the higher low-lying marshes, spreading during monsoonal rains, and on the highest peaks; *hookerianum*, erect herb with leaves flat on the ground, widespread in higher grasslands and on to highest peaks; *rigens*, tall herb, common on drier high grasslands.

Pimpinella (150, Africa, Eurasia, 1 sp. Pacific North America, a few in South America): *candolleana*, Cow Parsnip, common herb on open downs, crushed leaves faintly smelling of anise, Nilgiris and Palnis.

VALERIANACEAE

Valeriana (over 200, Eurasia, South Africa, temperate North America, Andes): *hookeriana*, herb, common on higher downs; *leschenaultii*, herb, also on highest downs, Doddabetta to Lakkadi and Pykara.

VIOLACEAE

Viola (500, cosmopolitan, chiefly northern temperate regions, but many in the Andes): *hamiltoniana*, Marsh Violet, prefers wet areas; *betonicifolia* subsp. *betonicifolia*, Spear-leafed Violet, amidst grasses; *pilosa*, Common Wood Violet, in sholas as well; all small perennial herbs on the downs.

XYRIDACEAE

Xyris (250, tropical and subtropical, but mostly American): *capensis* var. *schoenoides*, common herb in sunny and moist areas within grasslands, Nilgiris, Palnis and Shevaroys.

> **NOTE**: *BECAUSE SOME OF THE PLANTS OR THEIR ANCESTORS MAY HAVE COME FROM MADAGASCAR BEFORE THE INDIAN PENINSULA SPLIT AWAY AND MOVED NORTHWARDS IN THE CRETACEOUS PERIOD, THE WORD MADAGASCAR SUGGESTS A POSSIBLE AFFINITY. SOME OF THE PLANTS LISTED BELOW PROBABLY EVOLVED IN THE NILGIRIS.*

ACANTHACEAE

Andrographis (20, tropical Asia, mostly in India): *affinis, neesiana, producta*, subshrubs, widespread on Nilgiri grasslands, often abundant in steep, rocky places; Nilgiris a center of evolution.

Strobilanthes (over 400, Asia, Sri Lanka to Japan, the Philippines and Australia, prominently in Western Ghats of India): *kunthianus*, common multi-branched compact shrub to 2 m tall, on open grassland in flowering years, pale blue to mauve flowers, a multiennial with recorded flowerings in approximately 12 year intervals causing spectacular floral displays and its absence during the long intervals; people who have seen flowering Kurunji displays on mountain slopes remember them with awe, in Palnis as well; *sessilis*, small erect herb with stems only 30 to 45 cm tall, blue-purple to mauve flowers, a perennial flowering each year, Ootacamund to Pykara, Avalanche and into the Kundahs, not in Palnis.

ASCLEPIADACEAE

Ceropegia (160, Canary Islands, tropical Africa and South Africa, notably Madagascar, tropical and subtropical Asia): *ciliata*, small herb amid grasses, climber on shrubs, also in Palnis; *elegans*, herb, runs in grass or climbs on to shrubs, mostly east of Doddabetta to Kotagiri, southward from Nilgiris to Sri Lanka; *pusilla*, common, larger herb amid grasses of the downs, roots are called Toda potatoes, also in Anaimalais but not Palnis.

BALSAMINACEAE

Impatiens (about 550, both tropical and temperate, Eurasia and Africa, especially Madagascar and mountains of Sri Lanka, southern India): *chinensis*, Chinese Balsam, herb, stem unbranched to 50 cm tall, opposing leaves, mauve-pink to white flowers, common and widespread all over Nilgiris, also on the downs, but especially in damp places, perhaps the most widely distributed of all the balsams, higher areas in Western Ghats and down to 900 m, Bhutan, Assam, Khasi Hills and eastward to Burma and into China; *tomentosa*, annual erect herb with red-tinged stems, small rose-pink flowers, sometimes abundant in marshes on the downs, also thriving next to streams, widespread, Thalakundah, Pykara and Upper Bhavani — Western Ghats, Palnis as well.

COMPOSITAE

Anaphalis (35, Europe, Asia and Americas), 10 species in Nilgiris, herbs: *aristata*, aromatic flowers and sticky leaves, on downs, in drier places; *lawii*, common everywhere, often on poorer soils; *leptophylla*, white everlasting, in damp places on the downs; *wightiana*, common on downs, in damp and cooler niches.

Youngia (about 40, temperate and tropical Asia; originally from temperate Southeast Asia?): *fuscipappa*, more primitive herb, Avalanche, Sispara and south into Sri Lanka; *japonica* subsp. *genuina*, Japanese Hawk's Beard, herb, Western Ghats to Ashambu Hills in India — Indo-Malaya to Japan and Korea.

CYPERACEAE

Fimbristylis (300, tropical and subtropical, especially Indo-Malaya and Australia): *uliginosa*, common sedge on open downs, Ootacamund to Pykara and on tallest peaks, only Nilgiris and Palnis; look for dew glistening on the white styles in the early morning.

Kyllinga (60, tropical and subtropical, especially Africa): *melanosperma* (or *Carex melanospermus*?), perennial sedge on downs, Ootacamund to Pykara and Upper Bhavani, South Africa and Madagascar, Sri Lanka, Indo-Malaya.

Pycreus (109, tropical and subtropical): *unioloides* var. *angulatus* (or *Carex unioloides*?), sedge, prefers marshes, stem to 1 m, Nilgiris and Palnis.

EUPHORBIACEAE

Glochidion (300, Madagascar and tropical America [few], tropical Asia to Australia and Polynesia [many]): *neilgherrense*, small and untidy tree, male flowers with strong honey scent and female flowers with no scent, common species on downs, but also grows in sholas.

HALORAGACEAE

Laurembergia (4, tropical South America, tropical Africa, Madagascar, Indo-Malaya): *brevipes*, a small marsh herb, widespread on higher downs, Western Ghats, Nilgiris and Palnis; *hirsuta*, hairy herb on damp banks in grassy areas, Doddabetta to Sispara, Western Ghats, Nilgiris but not Palnis.

MELASTOMACEAE

Osbeckia (100, tropics from Africa to Australia; India with a large share of the species): *brachystemon*, small herb, widespread, amidst grasses; *leschenaultiana*, Red Osbeckia with red branches, purple flowers, a common shrub from Ootacamund to Pykara and Sispara.

PRIMULACEAE

Anagallis (28, mainly western Europe, Africa, Madagascar): *arvensis*, Common Pimpernel, widespread on downs, flowers close in dull or cold weather.

RUBIACEAE

Hedyotis (150, tropical Asia): *articularia*, widespread shrub on downs, from Ootacamund to Bangitapal and Mudimund, concentrating near streams; *stylosa*, shrub on downs, Ootacamund to Pykara and Sispara; *verticillaris*, herb on higher western downs, sometimes abundant near streams, plant often stemless and flat on the ground, long parallel-ribbed leaves forming a rosette.

COMMON PLANTS PROBABLY INTRODUCED BY HUMANS

COMPOSITAE

Eupatorium (1200, mostly America, a few in Europe, Asia and Africa): *glandulosum*, Goat Weed or the Curse of the Nilgiris, first introduced to a garden in Ootacamund after 1900, but now an escape all over.

DENNSTAEDTIACEAE

Pteridium (1, cosmopolitan, and thus all over the world):) *aquilinum*, bracken, possibly introduced by the British.

OXALIDACEAE

Oxalis (800, cosmopolitan, but mainly Central and South America, South Africa, herbaceous weeds, troublesome in cultivated areas and elsewhere): *latifolia*, from Mexico to Peru, now a widespread escape; *pes-caprae*, native of the Cape of Good Hope and probably introduced early by settling British, now a curse amid cultivated potatoes because of its tubers; *purpurea*, native of South Africa, probably introduced for British gardens in the early 1800s and now a weed in gardens; *spiralis*, from the Chilean Andes, another garden escape; *tetraphylla*, from Mexico, widespread garden escape, most troublesome in gardens.

PAPILIONOIDEAE

Cytisus (about 30, Atlantic Islands, Europe, Mediterranean): *multiflorus*, White Broom, bush, native to Algeria but introduced from the Iberian Peninsula; *scoparius*, Yellow Broom, another bush, introduced from Scotland and England.

Ulex (20, Europe, North Africa): *europaeus*, Common Gorse, probably introduced from Britain.

PLANTAGINACEAE

Plantago (265, cosmopolitan): *lanceolata*, Ribwort Plantain, a scattered weed.

VERBENACEAE

Lantana (150, tropical America, West Indies, tropical Africa and South Africa): *camara*, thorny tropical American shrub, common from plains to 2,100 m, gregarious and typically growing in patches, possibly the most widespread problem plant of India.

SHOLA FRINGE (FOREST — GRASSLAND ECOTONE) SPECIES

ACANTHACEAE

Strobilanthes asper, erect shrub to 6 m tall, purple-white flowers with a strong scent, within sholas but often more abundant in their borders, no defined period for dying off, Ouchterlony Valley into the precipitous western edge and higher downs beyond, not in, Palnis; *foliosus*, large gregarious shrub to 4 m tall, sometimes forming extensive masses, with pale blue flowers, often in flower and apparently a perennial, not dying out at set intervals, common in sholas and their borders, Coonoor to Ootacamund, Naduvattam and Sispara, also in Palnis; *urceolaris*, an erect shrub to 1 m tall with long internodes when in sholas, very low shrub with low branching in open grassland, sometimes abundant in borders, pale blue flowers, periodicity of dying remains unknown, near Ootacamund and in higher areas, also in Palnis; *zenkerianus*, gregarious shrub, mauve to pale violet flowers, periodicity of dying remains unknown, thrives within sholas and is locally abundant in borders and out into grasslands, bright green leaves larger on plants in shade, recorded at Coonoor and Doddabetta and mostly living in higher sholas, in Palnis as well.

AQUIFOLIACEAE

Ilex (400, cosmopolitan, except North America): *wightiana*, common tree in sholas, sometimes a dominant, near streams everywhere, flourishes in the open, forming small rounded trees; only on South Indian mountains, recommended for shola regeneration.

BALSAMINACEAE

Impatiens henslowiana, shrub to 2 m high, flowers white tinged pink, gregarious and forming clumps in moist shady places, also in shola borders and alongside streams, only in Sri Lanka and mountains of extreme southern India; *leschenaultii*, common balsam shrub, well-branched and very leafy to 1 m high and taller within darkened shola interiors, white flowers with a pink tinge, flowering year-round, common near Ootacamund within sholas and in their borders, widespread in area and elevation, Doddabetta to Pykara and the Kundahs, down to the Ouchterlony Valley, only in the Western Ghats, not the Palnis.

BERBERIDACEAE

Berberis (450, widespread in Eurasia, North Africa, North and South America): *tinctoria,* Common Nilgiri Barberry, within and bordering sholas, variable in size and form, thorny shrub to 3,200 m in the temperate Himalaya.

Mahonia (70, Indo-Malaya, mainly Himalaya to Japan, North and South America): *leschenaultii*, Holly-leaf Barberry, common large shrub in shola borders, higher elevations, closely related to *nepalensis* in the temperate Himalaya.

CAPRIFOLIACEAE

Lonicera (200, North America, Eurasia, South to North Africa, Himalaya, Malaysia, and to Philippines): *leschenaultii*, common, tangled climber, especially abundant in shola borders; *ligustrina*, compact shrub, uncommon, preferring shaded parts of shola borders; both being honeysuckles.

Viburnum (200, temperate and subtropical, especially Asia and North America, 16 in Malaysia): *cylindricum*, common small evergreen tree in shola borders, widely distributed from Sri Lanka to the Himalaya and western China, Southeast Asia; *erubescens*, shrub with forked white-barked branches and crimson leaf stalks, common in shola borders, higher elevations, including Doddabetta and Ootacamund.

COMPOSITAE

Senecio (covered already, see above): *neelgherryanus*, Nilgiri Ragwort, herb, spreading from shola borders into nearby grasslands; *walkeri*, with vines growing up into shola trees bordering grasslands.

Vernonia (1000, America, Africa, Asia and Australia, very common in grassy areas): *bourdillonii*, small shrub; *conyzoides*, sturdy herb; *malabarica*, stout shrub; *pectiniformis*, shrub; while all may grow on grasslands, they commonly thrive in shola borders.

DAPHNIPHYLLACEAE

Daphniphyllum (10, Indo-Malaya to Taiwan and Japan): *neilgherrense*, widespread tree, common in sholas and their borders, but sometimes spreading into degraded open areas nearby; in Sri Lanka, Western Ghats, to Java and Korea as well.

ELAEAGNACEAE

Elaeagnus (45, mainly Northern Hemisphere, Eursa to North America): *kologa*, undershrub to climber over tall trees, common in shola borders; mountains of Sri Lanka, Indo-Malaya and China.

ERICACEAE

Gaultheria (200, circum-Pacific and west to western Himalaya and south Indian hills): *fragrantissima*, very common shrub in shola borders, but spreading into grasslands, with leaves crushed for its oil; in Nepal and Bhutan to 2,600 m.

Rhododendron (over 1,000, mainly in northern temperate regions, with South China into the Himalaya being the world's main region of diversity; a lesser centre in North America; about 300 in highland New Guinea): *arboreum* subsp. *nilagiricum*, the ideal small tree coloniser and pyrophyte in the mountains of South India, spreading from sholas and their borders into grasslands.

ICACINACEAE

Gomphandra (33, tropical Asia to Solomon Islands): *coriacea*, small tree or shrub, common within sholas and in their borders.

MALVACEAE

Abelmoschus (15, tropical Africa and Asia, Australia): *angulosus*, Hill Mallow, tall and coarse perennial herb, often near streams, in shola borders, flowering in the coldest months, also spreading on to grasslands, Ootacamund to Kotagiri and below Kodanad; only in higher mountains of Sri Lanka and extreme south India.

MYRTACEAE

Rhodomyrtus (20, in mountains from Sri Lanka to Philippines, New Caledonia and Australia): *tomentosa*, hill guava, bush to small tree, thriving best on to open terrain from shola borders in mountains from Sri Lanka to Singapore.

OLEACEAE

Jasminum (300, Old World tropics and subtropics, over 50 in India, wild jasmine): *bignoniaceum*, erect shrub with bright yellow flowers, near sholas and all over the downs; *breviloban*, large climbing shrub, far up on to tree crowns, with terminal bunches of white flowers; *cordifolium*, shrub climbing up small trees, has large leaves and scentless white flowers; all adapted to shola borders.

POLYGALACEAE

Polygala (about 550, cosmopolitan, excluding New Zealand, Polynesia and the Arctic): *arillata*, Red-eye or Common Milkwort, yellow flowers, abundant shrub in shade of sholas, especially along borders, Coonoor, Kodanad and Ootacamund; at higher elevations from Sri Lanka to Bhutan, southern China and the Philippines.

RANUNCULACEAE

Clematis (250, cosmopolitan, chiefly in temperate regions): *munroana*, gregarious climber with vines reaching up into tree crowns, shola border the ideal niche with solar energy promoting growth, Sispara area; *wightiana*, woody climber with vines forming intertwined masses, Sholurmattam, near Ootacamund and to Avalanche; both only in southern India.

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *diffusus*, erect glossy herb with large yellow flowers, in moist exposed ground, stream banks and shola borders; also lives from the Himalaya to Burma and China.

RHAMNACEAE

Rhamnus (110, cosmopolitan): *wightii*, a large shola shrub or tree also growing on the downs, yellow flowers, common in shola borders, widespread over the higher Nilgiris; only in Sri Lanka and southern India.

ROSACEAE

Photinia (60, Indo-Malaya, mainly Himalaya to Japan, North America): *integrifolia* var. *sublanceolata*, large evergreen tree in sholas and smaller on grasslands, a pioneer species inclined to spread out from shola borders.

Potentilla indica, small prostrate perennial herb, yellow flowers and ripened red berries, flowering all year, locally abundant on shola floors, especially in borders and moist places, common all over Nilgiris; Sri Lanka, Western Ghats, Afghanistan, India, Himalaya, east to Malaysia, China and Japan.

RUBIACEAE

Psychotria (700, mostly warm regions): *nilgiriensis* var. *nilgiriensis*, shrub to small tree, at higher elevations, on Doddabetta, common in sholas and spreading from their borders on to the downs; restricted to South Indian mountains.

SAPINDACEAE

Dodonaea (60, widespread in tropics and subtropics, especially Australia): *viscosa* var. *angustifolia*, shrub to small tree, all over India, from plains high into the mountains, increasing in size with upward elevation, in shola borders and out onto drier grasslands.

TERNSTROEMIACEAE

Ternstroemia (100, in the tropics): *japonica*, common, evergreen tree to shrub, in sholas and their borders, but also a shade tree on open grassland; in parts of the Western Ghats, but not in the Palnis or Maharashtra, also in mountains from Khasi Hills to Sumatra, China and Japan.

Out from shola borders, there may be varied mixes of fringe (forest-grassland ecotone) species and shola species to produce a true savanna (sabana) with trees well represented. However, an abrupt shift from shola fringe to grassland is characteristic of Nilgiri vegetation, and savannas thus tend to be limited in areal extent. When annual firings of landscapes were prevalent, fire (and attendant degeneration of damaged trees through disease) tended to slowly destroy tree species until grassland dominated. Because rhododendrons were such exceptional pyrophytes, they often became lone sentinels on the grasslands. They could even survive when over eighty percent of their trunk diameters were burned away by flames. With the elimination of annual firings, savannas of limited areal extent may rapidly develop into sholas.

SHOLA SPECIES

ACANTHACEAE

Strobilanthes luridus, extensive straggling giant shrub to 6 m tall, remarkable lurid purple to blue, sometimes white, flowers in erect spikes to 25 cm long — at bases, lateral on old wood, flowering every year, forming dense undergrowth in sholas, widespread from Coonoor (Lamb's Rock road) to Naduvattam and Sispara, also in Palnis; *micranthus*, giant shrub to 10 m tall, with thick branches, stems so soft as to be almost herbaceous, large leaves, dark purple flowers, periods to dying off 15 years(?), within higher sholas (most likely seen in Governor's Shola and near Ootacamund), also in Palnis; *perrottetianus*, large shrub, soft with red-purple hairs, pale blue-pink or lilac flowers, dies in 10 year periods (?), Coonoor, Doddabetta, Pykara and Sispara down to the Ouchterlony Valley, not in the Palnis.

AQUIFOLIACEAE

Ilex denticulata, Nilgiri Holly, sometimes a large tree, common in sholas; only in mountains of South India and Sri Lanka.

ARACEAE

Arisaema (150, East Africa, tropical Asia, Atlantic North America to Mexico): *leschenaultii*, Common Cobra Flower, herb, in shady and cool places, thus mostly in sholas, Western Ghats; *tortuosum*, Rat's-tail Cobra Flower, widespread herb, in shade, mountains of India, from Shimla southward.

ARALIACEAE

Pentapanex (15, Himalaya to Taiwan, Java, Australia, South America): *leschenaultii*, well-branched tree or shrub, occasionally epiphytic, at higher elevations, widespread from Western Ghats to Himalaya, Burma and western China.

Schefflera (200, tropics and subtropics, including cloud forests): *racemosa*, medium-sized tree, common, often near streams, only in the Indian Peninsula and Sri Lanka.

BALSAMINACEAE

Impatiens campanulatus, shrub to 1.5 m high, white flowers with red throats, sometimes forming clumps on floor in very moist and shady places, also grows where water drips on rocks, near Coonoor — only in the Western Ghats, Palnis as well; *fruticosa*, erect, much branched shrub to 2.5 m tall, pink flowers with long spurs to 4 cm, particularly near streams within sholas, widely distributed from Coonoor to Kotagiri, Bikkapatti, Ebanad, Pykara and Naduvattam — Western Ghats, not the Palnis; *latifolia*, a herb up to 50 cm tall, grooved stems, deep rose to purple flowers, on moist shaded ground within sholas, also doing well next to streams, widespread from Doddabetta to Coonoor and Naduvattam — only in Sri Lanka and mountains of the Indian Peninsula; *modesta*, Sweet Seventeen, small herb, mauve-pink flowers, in shaded interiors, Pykara and Naduvattam — restricted to portions of the Western Ghats, not the Palnis; *pusilla*, small herb, only 10 to 17 cm high, flowers white with purple marks, widely distributed, from Doddabetta to Naduvattam, Mudimund and Bangihalla, highly variable, distinct form *rosmarinifolia* being bushier with broader leaves and greenish thin flowers, in contrast to the commoner form with longer and narrower leaves — only in southern Western Ghats, not the Palnis; *scabriuscula*, small herb, only 10 to 26 cm tall, branched from the base, white to pink flowers, no vestige of a spur, Naduvattam, Pykara and Sholur — from South Canara and Coorg to the Wynaad and upper Nilgiris only.

Like some orchids, there are balsams which prefer to live on rocks, e.g. *Impatiens acaulis*, small herb with stems from 5 to 30 cm, pink or white flowers to 4 cm wide, on wet rocks in western escarpment zone, Naduvattam to Sispara, near Avalanche and in the Kundahs, the Nilgiris and also Shevaroys below Shevaroyan; *scapiflora*, small herb with flowers near the top of the stem and leaves from the base, pink flowers, on wet rocks, widespread from Pykara to Mudimund and along the western escarpment south from Naduvattam — only in the Western Ghats, not Palnis.

CAPRIFOLIACEAE

Viburnum punctatum, small evergreen tree, white to light yellow flowers, common in lower parts of the Upland Island, not Ootacamund but lower downs to the west, Western Ghats from Karnataka south, Palnis as well.

CELASTRACEAE

Euonymus (176, with greatest numbers in the Himalaya, China and Japan): *crenulatus*, Spindle Tree or shrub, common near ground in shola interiors, especially near Pykara, red flowers at lower and pink flowers at higher altitudes.

Microtropis (70, Indo-Malaya to China, Mexico and Central America): *microcarpa*, shrub to tree, Ootacamund to Kotagiri, Western Ghats and Palnis; *ramiflora*, medium-sized evergreen tree, common, excellent for shola regeneration, also in Sri Lanka.

COMPOSITAE

Vernonia (1000, America, Africa, Asia and Australia, very common in grassy areas): *conyzoides*, herb, in Ootacamund and at higher levels; *monasis*, tree, conspicuous in April and May when its abundant flowers give off a scent; *pectiniformis*, common shola shrub, from Ootacamund to the Kundahs.

CRUCIFERAE

Cardamine (160, cosmopolitan, but chiefly temperate): *africana*, small perennial herb, common on shady and moist shola floors, higher mountains of Sri Lanka and India; in tropical mountains of Africa, Asia and America.

CYATHEACEAE

Cyathea (600, tropical and subtropical regions, but especially in mountains of wet tropics): *schmidiana* and *spinulosa*, two representative tree ferns living in the Nilgiris, typically in moist, darker shola interiors; the first recorded at Avalanche, Coonoor, Kilkotagiri and Ootacamund, the second at Bikkapattimund and Coonoor.

ELAEOCARPACEAE

Elaeocarpus (200, from Indo-Malaya to East Asia, Australia and into the Pacific; in tropical cloud-forests as well): *glandulosus*, Nilgiri Mock-olive Tree, often planted near villages, edible green fruit, in mid-level evergreen forests at Coonoor and Kotagiri, example of a species growing at subtropical mountain levels; *munronii*, Stately Tree, dark green fruit, Coonoor Sholurmattam, Naduvattam, Kinnakorai, i.e., lower portions of the Upland Island; *recurvatus*, tree, dark green fruit, common within sholas from Doddabetta to Avalanche and Mukerti.

ERICACEAE

Vaccinium (400, mainly temperate North Hemisphere, but also in tropical mountains, in South Africa but not the rest of Africa, Madagascar): *leschenaultii*, common shola tree with purple young leaves in April and May, only in mountains of Sri Lanka and South India.

EUPHORBIACEAE

Macaranga (280, tropics, Madagascar, Indo-Malaya to Australia and Pacific, many species having hollow stems inhabited by ants): *indica*, tree, another mid-level evergreen species, Devala and Sholurmattam, fast growing and often in secondary forest, scattered from Sikkim to the Nilgiris.

FLACOURTIACEAE

Hydnocarpus (40, Indo-Malaya to Australia): *alpina*, tree in dense mid-level evergreen forest, dark green to almost black foliage and brilliant red young leaves, often forming solid stands in moist valleys, as in forest below Coonoor.

ICACINACEAE

Nothapodytes (4, Sri Lanka to Taiwan and western Malaysia): *nimmoniana*, common in higher sholas everywhere, compact shrub to tree, excellent for shola regeneration; Sri Lanka, Western Ghats, Nilgiris, Palnis, also Assam, Burma to Thailand and Taiwan.

LAURACEAE

Actinodaphne (65, Indo-Malaya and East Asia): *salicina*, small evergreen tree, in Sispara area and Kundahs.

Cinnamomum (250, Indo-Malaya to East Asia; tropical cloud forests as well): *wightii*, large and tall shola tree, brown flowers, coppery new growth, common, from Doddabetta to Kollimund; only in Western Ghats, Palnis as well.

Cryptocarya (250, tropical, except Central Africa and subtropics): *lawsoni*, widespread in higher sholas, stout tree in the Kundahs; mostly in Western Ghats and not in the Palnis.

Litsaea (400, warm Asia and to Korea, Japan; Australia and America): *quinqueflora*, small tree, scattered in sholas, Avalanche to Coonoor and Sholurmattam; *wightiana*, large evergreen tree, everywhere in higher sholas, young leaves reddish, later develop characteristic galls; both species confined to the Indian Peninsula, Palnis as well.

Persea (150, tropics): *macrantha*, large tree, leaves often with characteristic galls, black to dark green fruit, widespread in lower sholas, to 2,100 m, Coonoor and below; Eastern Ghats, Palnis to Ashambu Hills.

Phoebe (70, Indo-Malaya, tropical America and West Indies; tropical cloud forests as well): *wightii*, common tree in higher sholas, sometimes a dominant, fresh foliage copper coloured, flowers and fruit all year; southern Indian hills, including the Palnis.

MAGNOLIACEAE

Michelia (50, tropical Asia and China): *nilagirica*, common tree, widespread in higher sholas, beautiful cream-coloured and fragrant flowers in August-September, Kotagiri to Ootacamund and the Kundahs; southernmost mountains, including the Palnis.

MELIOSMACEAE [= SABIACEAE]

Meliosma (100, warm Asia and America; in tropical cloud forests as well): *pinnata* subsp. *arnottiana*, deciduous tree in borders, 12 m tall in shola interiors but only 6 m on open grasslands, cream coloured flowers with a sweet honey smell – en masse and covering trees when in bloom, Ebanad to Ootacamund and Sispara Ghat, also in mid-level evergreen forests near Coonoor, Kotagiri and Pykara; *simplicifolia* subsp. *pungens*, Spiraea Tree, widespread evergreen, higher elevation replacement of the prior species, usually small, but larger in shola interiors, cream coloured fragrant flowers; both only in Western Ghats, Palnis as well.

MYRSINACEAE

Myrsine (7, Azore, Africa to China): *wightiana*, common tree in higher sholas, usually small but occasionally large; Western Ghats, Nilgiris and Palnis, also in Nepal, Bhutan, Assam and the Khasi hills.

MYRTACEAE

Syzygium (500, palaeotropical): *cumini*, wild tree and sometimes cultivated for its fruit, at lower, elevations, in sholas near Coonoor and Kotagiri, fruit gathered and sold, also spread from Indo-Malaya to Australia; *densiflorum*, common tall tree, sometimes dominant, Nilgiris, Palnis and Shevaroys; *calophyllifolium*, only in Nilgiris and on Adam's Peak in Sri Lanka, mainly over higher western Nilgiris, one of the largest shola trees, eventually [at over 18 m] an emergent; *montanum*, numbered among the largest of shola trees, widespread.

OLEACEAE

Ligustrum (*c*. 50, Europe to northern Iran, East Asia, Indo-Malaya to New Guinea and Australia): *perrottetii*, small evergreen tree, Kotigiri, Kalhatti to Upper Bhavani; only Nilgiris, Palnis and Shevaroys.

ORCHIDACEAE

Nilgiri orchids are herbaceous plants that may be terrestrial (rooted in the ground), sometimes requiring shade far in the interiors of sholas, or epiphytic (roots supported by host shrubs or trees, but not exploiting them for sustenance). Epiphyte orchids often do well amidst mosses on branches that are moistened or even drenched by incoming clouds and mist, thus living in what are generally called cloud forests. Some species of terrestrial or epiphytic orchids also occupy exposed rock surfaces. Few people realize that it is in rainy periods during the westerly monsoon and the reverse monsoon, reaching a climax in some areas during September, that many flowering orchids present magnificent floral displays that are beyond imagination in the dry period. What seems barren and colourless then has vividly coloured palettes inspiring awe and reverence after the rains have come. The Nilgiri Upland Island has a host of orchids, only the related genera of these orchids will in their international distribution be covered under three corresponding headings: 1) terrestrial orchids, 2) epiphytic orchids, and 3) orchid genera having at least one species that may inhabit rock surfaces.

Terrestrial Orchids: *Anoectochilus* (25, tropical Asia, Australia, Polynesia); *Brachycorythis* (32, tropical and South Africa, tropical Asia); *Calanthe* (120, warm parts of the world); *Cheirostylis* (22, tropical Africa, Asia, Pacific); *Coeloglossum* (2, temperate Asia, North America); *Cymbidium* (40, tropical Asia, Australia); *Disperis* (75, tropical and South Africa, Indo-Malaya); *Eulophia* (200, pantropic); *Habenaria* (600, tropical and warm countries, Old and New Worlds); *Pachystoma* (11, China, Indo-Malaya, North Australia, New Caledonia); *Pecteilis* (4, Indo-Malaya, East Asia); *Peristylus* (60, China, Taiwan, India to Australia, Polynesia); *Satyrium* (115, tropical Africa and South Africa, Indo-Malaya, Tibet, and China); *Seidenfia* (300, cosmopolitan, except New Zealand); and *Spiranthes* (25, cosmopolitan, except Central and tropical South America, tropical and South Africa).

Epiphytic Orchids: *Aerides* (40, India, Japan, Vietnam, Malaysia, not New Guinea); *Bulbophyllum* (900, tropical and temperate Southern Hemisphere); *Cirrhopetalum* (70, tropical Africa, Indo-Malaya to Tahiti); *Coelogyne* (200, West China, Indo-Malaya, Pacific); *Cymbidium* (see above); *Dendrobium* (1,400, tropical Asia to Australia and Polynesia); *Diplocentrum* (2, only in India); *Eria* (375, tropical Asia, Australia, Polynesia); *Gastrochilus* (20, India, East Asia, West Malaysia); *Liparis* (250, cosmopolitan, except New Zealand); *Luisia* (30, tropical Asia to Japan and Polynesia); *Oberonia* (330, palaeotropical); *Porpax* (10, India into Thailand); *Robiquetia* (20, India, Southeast Asia, Malaysia, to Solomons and Fiji); *Schoenorchis* (20, China, Indo-Malaya, Solomons, Fiji); *Sirhookera* (2?, probably only 1, India, Sri Lanka); *Thrixspermum* (100, Indo-Malaya, Southeast Asia to Taiwan, Australia and Polynesia); *Trias* (6, India, Southeast Asia); *Trichoglottis* (60, Taiwan, Indo-Malaya, Polynesia); *Vanda* (60, China, Indo-Malaya, Mariana Islands).

Orchid Genera with atleast one species that may inhabit Rock Surfaces: *Aerides, Coelogyne, Cymbidium, Gastrochilus, Habenaria, Schoenorchis, Vanda.*

Orchids Living Within Sholas: *Aerides ringens*, Rose Tree Orchid, always in shade, pink flowers before the westerly monsoon, all over the Nilgiris; Western Ghats.

Calanthe sylvatica, Ground Orchid, deep purple flowers, in deep shade, widespread to above 2,000 m, eastern Africa to Western Ghats, including the Palnis, Himalaya eastward to Japan; *triplicata*, Big Wood Orchid, ground orchid with tall racemes of white flowers, in deep shade, sometimes common and forming large patches, Kotagiri and Kodanad, in Longwood *Shola*, Coonoor and Doddabetta to Avalanche and Naduvattam, Sri Lanka, Western Ghats, Palnis, to Malaya, Australia and the Pacific.

Cheirosotylis flabellata, Small Ground Orchid with white flowers, lover of shade, where there is decaying organic matter, common on Snowdon, near Ootacamund, Coonoor to Kalhatti and Pakasuramalai; Sri Lanka and southern India, including the Palnis.

Cirrhopetalum gamblei, flowers are yellow-green with purple spots, epiphyte in the Kundahs and Naduvattam, near western escarpment, Kalhatti, Naduvattam and Pakasuramalai; Sri Lanka, Western Ghats, also the Palnis.

Coelogyne nervosa, Lesser Plantain Ground Orchid, white flowers, Coonoor to Sispara, Kotagiri to Ootacamund and Naduvattam; *odoratissima*, Sweet-scented Plantain Ground Orchid, yellow flowers, commonly growing in dense masses on trees, widespread, Doddabetta to Avalanche, Bangitapal and Lakkadi; Sri Lanka, Western Ghats, but not in the Palnis.

Dendrobium nanum, epiphyte with white flowers, in Naduvattam area; Western Ghats.

Disperis neilgherrensis, ground orchid with purple flowers, Coonoor and Ootacamund to Avalanche and Naduvattam; South India generally, extinct in the Palnis?

Eria nana, especially common on tree boughs with damp moss, transparent flowers, on slopes of Snowdon near Ootacamund, to Avalanche and Naduvattam, in Western Ghats and Palnis; *polystachya*, pale yellow flowers, Devarshola and Naduvattam; *reticosa*, orange yellow flowers with white tips, common in sholas, Coonoor and Kodanad to Ootacamund and Pykara; last two are epiphytes in Sri Lanka and Western Ghats, but not in the Palnis.

Eulophia spectabilis, large ground orchid with leaf blades 30 to 40 cm long, yellow flowers, in the Catherine Falls valley; tropical Himalaya to Western Ghats and Sri Lanka, eastward to Indonesia and New Guinea.

Gastrochilus acaulis, green-blotched purple flowers, epiphyte near Kotagiri and in the Catherine Falls valley; Sri Lanka, Western Ghats, Palnis as well.

Liparis atropurpurea, epiphyte in darkened interiors, dark purple flowers, higher elevations, Pykara, Avalanche, Mukerti and the Kundahs — Sri Lanka, Western Ghats, Palnis; *elliptica*, epiphyte in shade, ascending white, green or yellow flowers, Kotagiri and Doddabetta — Sri Lanka, Western Ghats, Palnis, Nepal eastward to Indonesia and Taiwan.

Oberonia brunoniana, pale yellow flowers, from Ootacamund to Pykara, Naduvattam and Bangitapal; platycaulon, white or pale yellow flowers, Mukerti Peak area and in the Kundahs, Ootacamund to Naduvattam; *verticillata*, light orange flowers, common, Bikkapattimund, Pykara to Avalanche: *wightiana*, common on trees, sometimes forming dense masses, pale yellow-green flowers, all over the higher Nilgiris; all are epiphytes, Western Ghats, Palnis as well, two latter species also in Sri Lanka.

Pecteilis gigantea, Robust Ground Orchid, to over a metre tall, fragrant white flowers, Ootacamund to Nadgani; tropical Himalaya to Western Ghats, Palnis as well, and as far as China.

Seidenfia densiflora, in deep shade, purple flowers, from Kotagiri and Ootacamund to Pykara and Bison Swamp; *rheedii*, Common Ground Orchid, thriving on humus in deep shade, yellow to rusty flowers, in the Naduvattam area; both ground orchids, Sri Lanka, Western Ghats, Palnis as well, and Indian Peninsula.

PEPEROMIACEAE

Peperomia (over 1000, tropics and subtropics, especially America, many being epiphytes): *tetraphylla*, Pepper-elder, abundant, small epiphytic herb on branches, often amidst mosses and in shade, Coonoor, Kotagiri, Pykara and Upper Bhavani; Himalaya, Khasi Hills and into Burma, China, Australia, Africa and America.

PIPERACEAE

Piper (2000, tropical): *mullesua*, Ootacamund, common in Longwood Shola, near Kotagiri; *schmidtii*, Toda Pepper, prefers shade like the others, in sholas near Ootacamund, widespread; *wightii*, Coonoor and lower places; wild pepper species, rooting in host trees as vines spread upwards, Western Ghats.

PITTOSPORACEAE

Pittosporum (150, tropical and subtropical Africa, Asia, Australia, New Zealand, Pacific): *neelgherrense*, small tree, widespread; *tetraspermum*, Common Yellow Sticky-seed, small tree, widespread; Western Ghats, Palnis as well.

RANUNCULACEAE

Ranunculus (400, cosmopolitan, temperate and cold regions, tropical mountains): *wallichianus*, Common Buttercup, gregarious herb spreading by runners, in moist and shaded ground, especially within shola interiors, flowers orange to yellow, Kotagiri, Ootacamund and Naduvattam; only in hills of southern India and Sri Lanka.

RHAMNACEAE

Rhamnus virgatus, Indian Buckthorn, normally erect but a spiny and stunted shrub in dry places, a part of forest undergrowth, widespread; southern India, temperate Himalaya and to western China.

ROSACEAE

Fragaria (15, North America, Chile, Eurasia and South India): *nilgerrensis*, White Strawberry, white to yellow flowers, common in shady places, mainly sholas, Kotagiri to Ootacamund, Pykara and Upper Bhavani; India, eastern Himalaya to western China.

Photinia lindleyana, Lindley's Rowan, small tree with crooked branches, Ootacamund, Pykara and the Kundahs, not in Palnis.

RUBIACEAE

Ixora (400 sp., tropical) *notoniana*, short and slender tree, white tinged with pink to red flowers, common from inner darkened parts to shola borders, widespread over lower parts of the Upland Island; only in mountains of extreme southern India.

Lasianthus (150, Indo-Malaya; 15 sp., trop. Africa): *acuminatus*, shrub, like coffee bushes, to 6 m from shola floor, abundant and sometimes dominant, widespread with distribution paralleling that of the following species: *venulosis*, well-branched shrub, common in the shade of trees, sometimes dominant, yellow white flowers, widespread and into highest areas as well; both only in the mountains of extreme southern India.

Pavetta (400, palaeotropical) *breviflora*, small tree to shrub, to 8 m tall, white flowers, undergrowth on shola floors, widespread in higher areas; only in Western Ghats.

Psychotria (700, mostly warm regions): *bisulcata*, shrub, starry green flowers, in shade, next to Lamb's Rock Road, Kodanad and widespread, to tops of peaks; *glandulosa*, large shrub to small tree, green-white flowers, in shade, widespread but at lower elevations; both only in the Western Ghats.

RUTACEAE

Euodia (45, tropical Africa, Asia, Australia and Pacific): *lunur-ankenda*, small tree, yellow-green flowers, everywhere in sholas, in places to high elevations; Sri Lanka, southern Indian hills, Khasi Hills and east to Java.

Toddalia (1, tropical Africa, Madagascar, tropical Asia): *asiatica* var. *floribunda*, rambling woody climber, as thick as a human arm at ground level, twigs armed with curved prickles, cream coloured flowers, common in sholas, Coonoor, Pykara to the Kundahs; widely in India and to China and Java.

SAPOTACEAE

Isonandra (10, Sri Lanka, southern India, Malay Peninsula, Borneo): *perrottetiana*, tree, yellow and fragrant flowers, locally abundant in sholas at higher elevations, particularly in the Kundahs; confined to Western Ghats.

Xantolis (100, Tropics): *tomentosa*, tree with thorns, cream coloured flowers, sometimes a dominant in sholas, flushing a blaze of scarlet when leaves are young in December; var. *elongioides*, over a wide elevation range, from Sirur to Ootacamund, confined to southern India.

STAPHYLEACEAE

Turpinia (about 35, Sri Lanka, Indo-Malaya to Japan, central and tropical South America): *nepalensis*, one of the commonest shola trees, sometimes dominant, small pale yellow to cream coloured flowers, sometimes part of a substorey but also an emergent, all over and thriving in the higher elevations, ideal for shola regeneration; Western Ghats, southeast Himalaya, Assam, Burma to Malaya, Yunnan in China.

SYMPLOCACEAE

Symplocos (350, tropical and subtropical, Asia into Australia, Polynesia and America, often at higher altitudes): *foliosa*, tree with smooth grey bark and silky young leaves, white flowers, mainly in higher western sholas from Doddabetta to Pykara and Avalanche — only in Western Ghats and into southern Kerala; *laurina*, a carpet of yellow leaves below the small tree or shrub reveal its presence in a shola, white flowers with a yellow tinge, mainly east of Doddabetta and into mid-level evergreen forests near Coonoor and Kotagiri — South India mountains and from Sikkim to the Khasi Hills and on to China, Japan and Australia; *obtusa*, moderate sized to large tree, white flowers, around Doddabetta and over the higher southwestern Kundahs, only on southern Indian hills.

TERNSTROEMIACEAE

Eurya (130, Indo-Malaya to East Asia, and into the Pacific): *nitida*, perhaps a shrub near Ootacamund, but also a large interior shola tree, white flowers, common over higher areas; mountains in Sri Lanka, India and to Southeast Asia, China and Japan.

THEACEAE

Gordonia (40, Indo-Malaya to Taiwan; 1 sp. in southeastern US): *obtusa*, moderate-sized evergreen tree; beautiful large cream to white flowers with many yellow stamens in middle, reminding one of tea flowers, showy, forming carpets on ground below when falling; fairly common and especially near water, Ootacamund — in the swamp below Havelock Road and in sholas on the downs, Coonoor and Pykara, but more common east of Doddabetta; only in Western Ghats, Palnis as well.

THYMELEACEAE

Gnidia (100, tropical Africa and South Africa, Madagascar, southwestern Arabia, western portion of Indian Peninsula and Sri Lanka): *glauca*, well-branched shrub or small tree, yellow flowers, in Nilgiri sholas, widespread, with considerable elevation range, but more common in the lower parts of the Upland Island; var. *sisparensis*, shrub, mainly the Kundahs, Palghat Hills just to the south of the Nilgiris, Ebanad - Sirur and into old Mysore just to the north; widely ranging in Sri Lanka, peninsular India and in Africa, from Malawi to Ethiopia, the Sudan and Mozambique.

URTICACEAE

Chamabaina (2, Indo-Malaya to Taiwan): *cuspidata* herb with male and female flowers, flowering in August, uncommon, only from Naduvattam to Terrace Estate and along the western escarpment with moist sholas, also on moist ground next to streams.

Droguetia (12, tropical Africa and South Africa, Madagascar, Arabia, South India, Java): *iners* subsp. *urticoides*, herb, cream flowers green-tinged throughout the year, gregarious, forming dense mats in moist and shady places on ground within shoals, widespread and in highest areas; mountains of South India and Java.

Elatostema (200, tropics, Old World): *acuminatum*, in gorge opposite Bangitapal bungalow, also Coonoor and Sispara, Sri Lanka, South India, Khasi Hills into Malaya; *lineolatum*, Naduvattam and western escarpment to Sispara, Sri Lanka, South India, tropical Himalaya to Khasi Hills; *sessile*, in sholas from Ootacamund to Coonoor, Naduvattam and Avalanche — southern India, Himalaya, from Chamba to Sylhet (Bangladesh) and much farther eastward to Malaya and Japan, also tropical Africa; *surculosum*, sometimes epiphytic on tree trunks, widespread form Coonoor to Doddabetta and Naduvattam to Avalanche — Sri Lanka, southern India, Himalaya from Shimla (Himachal Pradesh) to Nagaland; all four are herb to undershrub species, with cream flowers, thriving in deep shade within moist evergreen sholas and on moistened rocks in stream valleys.

Girardinia (8, tropical Africa, Madagascar, Indo-Malaya, East Asia): *palmata*, Nilgiri Nettle, herb to shrub, spreading on ground in shade, avoid long stinging hairs on leaves, flowers also armed with numerous stinging hairs, widespread and common, Kotagiri, Coonoor and Ootacamund to Naduvattam; confined to hills of extreme southern India.

Laportea (23, tropical and subtropical, South Africa, Madagascar, temperate East Asia, eastern North America): *crenulata*, Elephant or Fever or Devil Nettle, stout shrub to small trec with soft stems, bark white and smooth with fibres useful for cordage, sting from hairs on leaves very painful and lasting, more so when plant is flowering, sometimes also induces violent sneezing and fever — only in Western Ghats(?); *terminalis*, Milder Stinging Nettle, herb in deep shade, locally abundant, green-white flowers, stingers on stems and leaves, Kotagiri, Ootacamund to Naduvattam and Avalanche — in mountains of Sri Lanka, South India, Kumaon to Bhutan in the Himalaya, Tibet and to Malaysia and Central China.

Lecanthus (1 tropical Africa, 1 Indo-Malaya into East Asia, 1 Fiji): *peduncularis*, low-lying succulent herb, in moist and shaded places, Ootacamund to Pykara and Naduvattam; Africa, India, Southeast Asia, into Java, southern China and Taiwan.

Pilea (400, Tropics): *wightii*, Soft Nettle, annual or perennial herb forming mats on deeply shaded evergreen shola floors, without stinging hairs, flowers cream with green tinge, locally abundant, highest areas Doddabetta and Bikkapattimund; Sri Lanka, southern Indian hills, temperate Himalaya and mountains to Java.

Appendix 3: Nilgiri Endemic Species and Endemic Varieties

Based upon listings or first descriptions in Abraham and Mehrotra (1982); Balasubramanian (1972); Bhargavan and Mohanan (1982); Blasco (1970); Fyson (1932); Gamble (1967); Henry, Vivekananthan, and Nair (1978); Joseph and Vajravelu (1981); Karunakaran (1991); Manilal and Kumar (1984 a,b); Mohanan and Balakrishnan (1991); Nair (1991); Nair *et al.* (1982); Nayar (1980); Rathakrishnan and Chithra (1984); Shetty and Vivekananthan (1981); Subbha Rao and Kumari (1975); Subbha Rao, Kumari, and Chandrasekharan (1973); and Vajravelu, Rathakrishnan, and Bhargavan (1983).

MH = Madras Herbarium, Coimbatore; CNH = Central National Herbarium, Kolkata (= Calcutta).

(*) Endemic to the Kundah hills in the western Nilgiris (+) Nilgiri endemics elsewhere which also live in the Kundahs

ACANTHACEAE

**Andrographis lawsoni* Gamble, low shrubs in grassland, dark brownish-purple flowers, fairly common; Upper Bhavani to Bangihalla, Toda hamlet of Koshti, 2,000-2,300 m.

Andrographis lobeloides Wt., procumbent herb, small leaves, large brown flowers; fairly common on grassland, Coonoor and Ootacamund to Pykara, 1,800-2,400 m.

Andrographis stellulata Cl., erect herb, leaves stigose above and tomentose below, pale pink flowers, rare, at about 1,800 m.

+*Strobilanthes amabalis* Cl., sticky shrub, pink flowers, (?)10-year period, fairly common, 1,000-1,800 m.

+*Strobilanthes lanatum* Nees, beautiful erect shrub, green parts covered with yellow wool, pale blue flowers, dying-off intervals of perhaps 6 or 7 years, on higher Kundah grasslands, spectacular in spreading out on to sheer rocky cliffs of the western escarpment, Ootacamund to Sispara.

+*Strobilanthes papillosus* T. Anders., large shrub with big blue flowers, dying out periodicity unknown, only in the higher sholas and perhaps best known from flowerings at Doddabetta and Sispara in 1883, now rare.

+*Strobilanthes wightianus* Nees, low gregarious shrub, pale blue flowers every year, fairly common, 1,800-2,400 m.

+*Strobilanthes sessilis* Nees var. *sessiloides* Wt., small undershrub, flowering annually or at short intervals throughout the year, mauve flowers, 2,000-2,600 m.

**Strobilanthes violacea*, large shrub with beautiful blue to purple flowers, common but rarely in bloom and therefore believed to have long periods (13 years?) before dying out, only thriving within the highest sholas and on grasslands near Bangitappal and Sispara (in MH).

**Thunbergia bicolor* (Wt.) Lindau, large climber, little known, Sispara Ghat, *c.* 1,500 m.

APIACEAE

+*Heracleum hookerianum* Wt. & Arn., large herb with leaves on the ground, fairly common on grasslands, Snowdon to Avalanche.

AQUIFOLIACEAE

**Ilex gardneriana* Wt., Sispara Ghat, a scarce shrub or small tree, at *c.*1,800 m (no specimen in MH).

ARACEAE

**Arisaema translucens* Fisch., herb, Thaishola, at *c.* 1,600 m (in MH).

Arisaema tuberculatum Fisch., rare and virtually unknown, 2,100-2,250 m.

+*Arisaema tylophorum* Fisch., fairly common, 1,800 m and above.

ARALIACEAE

**Schefflera rostrata* Harms., shrub to large tree in sholas, fairly common, above 2,100 m.

ASCLEPIADACEAE

+*Baeolepis nervosa* (Wt. and Arn.) Decne, climbing undershrub, the only endemic genus of the Nilgiri montane flora and the only species in the genus, fairly common; easterly Nilgiris, in forests below Coonoor and from Wellington to Kotagiri and Kodanad, 1,500-2,250 m.

Caralluma nilagiriana Kumari and Subbha Rao, between Ebanad and Anaikatti, near 900 m.

ASPLENIACEAE

Asplenium exiguum Bedd., fern collected from the river bank above Kalhatty Falls (1,100 m), in *c.*1860 by Beddome, later collected again on rocks close to the original site; also found on way to Adaripatti, at 1500 m.

BALSAMINACEAE

+*Impatiens clavicornu Turcz*, white orchid balsam, small herb to *c.* 30 cm high, single stem and leaves from the base, white flowers, sometimes abundant in the grasses of the downs, flowering July to September with monsoonal rains, like so many of the balsams and orchids; widespread, Coonoor to Doddabetta, Pykara and Mudimund, 1,800-2,400 m.

Impatiens cuspidata Wt., well-branched shrub, often over I m tall, stem and branches covered with blue-white powder, pale pink flowers, common alongside Lamb's Rock Road from Coonoor, widely distributed within sholas to Kodanad and Sispara, 1,500-2,100 m; also, according to Dr. Tarun Chhabra, "a variety with brighter pink flowers in the Sispara area."

Impatiens debilis Turcz., herb with small pink flowers, rare; rediscovered lately by Chhabra in the Sispara area.

**Impatiens denisonii* Bedd., herb, pink flowers, on wet rocks, Sispara Ghat, rare, 900-1,500 m; rediscovered by Chhabra in 2002.

**Impatiens laticornis* Fisch., very small herb to 15 cm tall, white flowers with yellow to orange hairs or pink with magenta hairs, to 4 cm across, now an epiphyte on wet rocks or tree trunks, still thriving best in deep shade of sholas, Naduvattam to Sispara and particularly in the western escarpment zone, elsewhere in Kundahs above 2,400 m, rare; rediscovered by Chhabra near Mukerti and in the Western Catchments, and seen by him many times over the years.

**Impatiens lawsoni* Hook, a small herb, remarkable for surviving on wet rocks in the dense shade of wet sholas, only in the Kundahs, rare; "with many, many variations" according to Chhabra, who has found this species in the areas of Bangitappal, Mukerti and Nilgiri peaks, and in the Western Catchments.

**Impatiens levingei* (Hook.) Gamble, small herb, with leaves and stems rising from the base, leaves nearly round, carmine flowers, prefers living on wet rocks, seen next to Lamb's Rock Road near Coonoor, Hulikal and slope below the Toda hamlet of Pishkwasht, widespread in the lower levels of the Upland Island.

**Impatiens munronii* Wt., undershrub in the dense shade of sholas, sparingly branched and up to 60 cm tall, flowers a mixture of green, white and pink, Sispara Sholas, but Chhabra also found it past Nadgani, off the path from Bangitappal to Sispara, 1,500-1,900 m.

**Impatiens neo-barnesii* Fisch., most extraordinary of the balsams, having evolved into an epiphyte on moss-covered tree trunks and branches exposed to heavy rain and mist from Malabar, leaves and flowers hanging down, very fragile cream to white flowers, wing petals curled into a tube from which water drips, in deep shade of very wet sholas or scattered trees in the Kundahs — only in a limited portion of the western escarpment zone (start looking from near the top of Mukerti), typically ranging to 2,450 m, rare; more recently (1970) recorded in Nilgiri Peak R.F. and also rediscovered by Chhabra in 2001, near Bangitappal and Pandiar, and in the Western Catchments; he notes that this species "has an earlier climax in flowering, in August rather than September" (no specimen in MH).

**Impatiens nilgirica* Fisch., very small herb, stem and leaves rising from base, stems from 16 to 30 cm tall, leaves rounded, pink flowers, in grass on the Kundahs, Avalanche to Mukerti Peak, also on rocks, up to the tops of peaks, rare; rediscovered by Chhabra (photograph of the flower by Chhabra on the front cover of *Sanctuary*, 1997, No. 2; in MH).

+**Impatiens orchioides* Bedd., very small herb with white flowers, normally on ground in wet sholas, but occasionally epiphytic on a mass of branches — only at high elevations near Avalanche and in the western escarpment zone of the Kundahs, fairly common to 2,450 m; found by Chhabra near Mukerti, Bangitappal and in the Western Catchments.

**Impatiens rufescens* (Wt. & Arn.) Benth., Pink Marsh Balsam, small herb, stems rising and forming clumps, rose pink flowers, on Wenlock Downs, banks of the Pykara River and in swamps within the downs, rare; "its range extends to the Mukerti area" Chhabra.

+**Impatiens tenella* (Wt. & Arn.) Heyne, slender small herb, flat pink to rosy flowers, growing in moist sholas from Naduvattam and in the western escarpment zone to Sispara, at *c.* 1,800 m.

BERBERIDACEAE

Berberis nilghiriensis Ahrendt., rare and hardly known.

CAPRIFOLIACEAE

+*Viburnum hebanthum* Wt. & Arn., a small spreading tree with bright green foliage, in the same habitats as *erubescens*, often on the outskirts of sholas; known from Ootacamund to Pykara, 1,800-2,400 m.

CELASTRACEAE

Microtropis densiflora Wt., mostly on outer slopes of the far western Nilgiris, below Sispara and in dense forest; found near Pykara in 1971.

+*Microtropis ovalifolia* Wt., fairly common shrub, Coonoor, Pykara, and generally near streams in the western Nilgiris, 1,800-2,400 m.

COMPOSITAE

+*Anaphalis neelgerryana* (Sch.-Bip. ex DC) DC., low, much-branched shrub with small leaves, preferring dry and exposed places, fairly common, above 2,100 m.

+*Anaphalis notoniana* DC., herb with thick soft leaves, fairly common; Church Hill in Ootacamand, Doddabetta, hill behind Avalanche, above 2,100 m.

**Helichrysum wightii* (Hook.) Cl. ex Hook., herb with woody rootstock in grasslands between Bangitappal and Sispara, its woolly leaves sometimes colouring the landscape a silvery white above Sispara, at about 2,200 m (Specimen in MH).

**Myriactis wightii* DC var. *bellidioides* Hook. f., scapigerous herb in grassland within the Bangitappal Valley, Bangihalla (in MH).

**Senecio kundiacus* Fisch., herb in grasslands, rare (no specimen in MH).

**Senecio lawsonii* Gamble, slender herb in grasslands, fairly common; Bangihalla, between Avalanche and Sispara, Bangitappal, Sispara; collected by Shetty at Bangihalla and Sispara after 85 years, 2,000-2,300 m (in MH).

+*Senecio lessingianus* (Wt. & Arn.) Cl., in the western escarpment zone and above Neduvattam, fairly common, above 1,800 m.

+*Senecio polycephalus* (DC.) Cl., erect herb, fairly common on grasslands, Snowdon slopes, above 1,800 m.

**Youngia nilgiriensis* Babc., herb in grasslands, a more primitive species, apparently a relict, possibly ancestral type from which Section Meomeris arose, known from Sispara area at *c.* 2,060 m, rare (no specimen in MH).

CONVOLVULACEAE

+*Argyreia nellygherya* Choisy, a large climber, to 1,800 m.

CYPERACEAE

Ascopholis gamblei Fisch., erect herb, collected at Ootacamund, rare (no specimen in MH).

Carex pseudo-aperta Boeck ex Kuek., at about 1,800 m, rare.

Fimbristylis latinucifera Govindarajulu, near Pykara, at *c.* 1,950 m.

ERIOCAULACEAE

Eriocaulon pectinatum Ruhl., rare, only in the collection of Perrottet(?).

+ *Eriocaulon robustum* Steud., White-tailed Hatpin Flower, Coonoor and banks of the Pykara River, mostly above 1,500 m.

EUPHORBIACEAE

**Glochidion sisparense* Gamble, tree, Sispara, at *c.*1,500 m (no specimen in MH).

**Phyllanthus fimbriatus* (Wt.) Muell. Arg., glabrous shrubs in evergreen forests, Carrington to Kinnakorai, Sispara Ghat, at *c.* 2,000 m (in MH).

Phyllanthus megacarpa (Gamble) Kumari and Chandrabose, rare, near Devala in the Wynaad, at *c.* 900 m (not located since type collection).

GENTIANACEAE

+*Swertia trichotoma* (Wt. & Arn. ex Wt.) Wall., ex. Cl. Wall., tall leafy herb, fairly common, to 2,150 m.

GRAMINEAE (Smaller Grasses)

Agrostis schmidii (Hook. f.) Fisch., at Ootacamund (no specimen in MH).

Andropogon longipes Hack.

+*Andropogon polyptychus* Steud., in upper Nilgiri marshes, mainly in far west.

**Arundinella purpurea* Hochst. ex Steud. var. *laxa* Bor, very distinct variety with long pedicels, Sispara.

Arundinella purpurea Hochst. var. *purpurea*, the only aluminum accumulator in the family.

Arundinella setosa Trin. var. *nilagiriana* Subbarao et Kumari, at Koilbetta, near Ebanad; like *A. s.* var. *lanifera*, but has hirsute glumes instead (in MH).

+*Cymbopogon polyneuros* (Steud.) Stapf, Doddabetta, Mukurti, Ootacamund and Pykara, this grass contains an oil with a pleasant odour but is not used commercially, 1,900-2,500 m.

Dichanthium pallidum (Hook f.) Stapf ex Fisch. (no specimen in MH).

Eriochrysis rangacharii Fisch., fairly common near Pykara; only Indian representative of an otherwise wholly tropical African and American genus (in MH).

Helictotrichon polyneurum (Hook. f.) Henr., Doddabetta, distinctive looking, fairly common, 2,400 m.

Isachne deccanensis Bor, on downs near Ootacamund (no specimen in MH).

Isachne oreades (Domin) Bor, only in the Gudalur Ghat area (in a swamp within woods).

Poa gamblei Bor, fairly common, above 2,500 m.

GUTTIFERAE

Hypericum japonicum Thumb. var. *major* Fyson, a trailing weak-stemmed herb, on western grasslands, rare (no specimen in MH).

LABIATAE

Leucas rosmarinifolia Benth., a fairly common bush with a flat top, often on roadsides, northeastward from Ootacamund, to Kotagiri, including the area with the Toda hamlet of Pishkwasht.

Orthosiphon rubicundus Benth. var. *hohenackeri* Hook. f., a herb with many branches, at about I,850 m.

LAMIACEAE

Pogostemon nilagiricus Gamble, rare, soft herbaceous plant, on outskirts of sholas and on neglected broken ground, from Coonoor to Lovedale and Ootacamund (no specimen in MH).

+*Pogostemon paludosus* Benth., in wet places near Ootacamund and at Sispara, rare, 1,800 m and above, rare.

+*Teucrium wightii* Hook. f., fairly common, a stout-stemmed herb with thick, soft leaves, from Ootacamund to Dodabettta, mostly above 2,100 m.

LAURACEAE

Actinodaphne lanata Meisn., tree with lanceolate leaves, in sholas, 1,500-1,800 m.

+*Cinnamomum perrottetii* Meisn., fairly common shrub or small tree in sholas near Bangitappal and Avalanche, above 1,800 m.

LORANTHACEAE

Dendrophthoe neelgherrensis (Wt. & Arn.) Tieghem., Scarlet Loranthus, named after the dense bunches of slender crimson-scarlet flowers, Ootacamund to Naduvattam, 1,050-2,400 m.

MELASTOMACEAE

Memecylon flavescens Gamble, tree or large shrub with many branches, in sholas near streams, Avalanche and Sispara; collected by Vivekananthan from the type locality after about 83 years, 2,000-2,300 m (in MH).

Memecylon lawsoni Gamble, near Devala in southeast Wynaad, at *c.* 900 m (in MH).

Memecylon sisparense Gamble, large shrub or small tree, from Sispara Ghat, at about 1,500 m (in MH).

+*Sonerila elegans* Wt., an erect herb with thick stems and mauve flowers, at Sispara and in other parts of the western Nilgiris, 1,800 m and above.

MIMOSACEAE

+*Acacia hohenackeri* Craib., a climbing shrub with small recurved prickles, Coonoor, Kundahs, collected at Bimka Shola in 1970, rare.

MYRSINACEAE

Embelia gardneriana Wt., a climbing shrub, Sispara Ghat, at about 1,600 m (in MH).

MYRTACEAE

Syzygium benthamianum (Wt. ex Duthie) Gamble, small tree or large shrub, Sispara, 1,800 m (no specimen in MH).

ORCHIDACEAE

Eria albiflora Rolfe, pure white flowers, Ootacamund and T. R. Bazaar, 2,000-2,400 m, collected in 1899 by Barber, at Ootacamund, and more recently from the Nilgiris and the Silent Valley, rare (in MH).

+*Eria mysorensis* Lindl., small epiphyte, white flowers tipped with pink, flowering peak in September, Kodanad shola, western slopes of the Nilgiris, Naduvattam, 1,800 m.

Habenaria denticulata Reichb., very rare (no specimen in MH).

Habenaria fimbriata Wt., white flowers, 1,500-2,100 m, rare (no specimen in MH).

Habenaria polydon Hook., now extinct? (no specimen in MH).

Liparus indiraii Manilal et Kumar, in Silent Valley, named after Indira Gandhi (in CNH).

Oberonia bisaccata Manilal et Kumar, found near Research Centre, Silent Valley (in MH).

Porpax chandrasekharanii Bhargavan et Mohanan, discovered in Silent Valley (in MH).

+*Robiquetia jospehiana* Manilal & Sathish, Chembotti, Naduvattam and Silent Valley; according to Chhabra, also in the Sispara area.

Spiranthes sinensis (Pers.) Ames var. *wightiana* Lindl., terrestrial and endangered, flowers in a dense cylindrical spike, in the Bangitappal to Sispara area (in MH).

Thrixspermum muscaeflorum Rao & Jos. var *nilagiricum* Jos. & Vaj., very small epiphytic orchid, common on slender branches of small trees, near Kundah River in Tamil Nadu, first discovery of the genus in South India (in CNH and MH).

Trias stocksii Benth. ex. Hook.f., Silent Valley and Chandanathode in the Western Ghats.

Vanda wightii Reichb. f., the type location remains unknown, very rare (no specimen in MH).

OXALIDACEAE

**Biophytum polyphyllum* Munro, in sholas, herb with very long leaves having minute leaflets (30 to 50 pairs), fairly common, above Sispara, Thaishola, Carrington to Kinnakorai, 1,800-2,200 m.

PAPILIONACEAE

Alysicarpus beddomei Schindl., on Pakasuramalai, at about 2,030 m, rare.

+*Crotalaria barbata* (Wt. & Arn.) Grah. ex Wt. & Arn., sturdy shrub with erect flower spikes, bright yellow flowers, in sholas, fairly common, near Pykara and on Snowdon slopes, above 2,000 m.

Crotalaria candicans Wt. & Arn., erect tree, 3 to 4 m tall, very leafy, regular upward-sloping branches ending in large panicles of pure yellow flowers, thrives on steep slopes and on the downs, creating spectacular sights with mass bloomings, as seen on top of Sigur Ghat in July to September, fairly common, Coonoor, Kateri, Kodanad, Kottabetta and Madinad, to about l,850 m.

+*Crotalaria formosa* (Wt. & Arn.) Grah., low-growing shrub with dense, short, thick flower racemes, yellow flowers, fairly common in sholas and on grasslands, on Snowdon slopes near Ootacamund, Doddabetta to Avalanche and Pykara, above 2,100 m.

Dalbergia gardneriana Benth., fairly common, a climbing shrub with white flowers, Coonoor, Kalhatti and Sholurmattam, 1,500-2,150 m.

PIPERACEAE

**Piper pykarhense* C. DC., presumed found near the Pykara River, biotic disturbance due to dam building may have caused this species to become extinct.

POACEAE [BAMBUSEAE = LARGER GRASSES)]

+*Arundinaria wightiana* Nees var. *hispida* Gamble, widespread, growing next to shola streams at higher elevations, essential for final roofing phase of Toda hut construction, 2,100-2,300 m.

Silentvalleya nairii Nair, new genus, tufted perennial grass, discovered in the Silent Valley (in MH and CNH); related to genera *Diplachne* P. Beauv., *Gouinia* in America and *Lophacme* in Africa.

ROSACEAE

**Photinia serratifolia* (Desf.) Kalkman var. *tomentosa* (Gamble) Vivek and Shetty, small tree in sholas; Avalanche, Bangitappal, Lakkadi, toward Sispara, in the highest southwestern Kundahs; collected by Shetty from the type locality after 80 years, 2,000-2,200 m.

+*Rubus rugosus* Sm. var. *thwaitesii* Focke, a large prickly shrub with purple-black fruit, common on Doddabetta and other high elevations, often above 2,400 m.

RUBIACEAE

**Hedyotis hirsutissima* Bedd., low-growing, shrub with stout stems and branches, in rock crevices and on southwestern grasslands, pale lilac flowers, fairly common, Bangitappal to Sispara and the Kundahs, collected by Shetty at type location after 80 years, 2,000-2,300 m (in MH).

Hedyotis silent-valleyensis Vaj., Rath. and Bharg., on one grassy slope, Silent Valley (in MH and CNH).

**Hedyotis sisparensis* Gage, an undershrub with quadrangular branches and pale leaves, near Sispara, at about 2,200 m, rare (no specimen in MH).

+*Lasianthus ciliatus* Wt., a stout shrub, with prominent leaf-nerves, in deep shade of sholas edging the western escarpment, also below Kodanad and next to Lamb's Rock Road, to about 2,200 m (in MH).

Ophiorrhiza incarnata Fisch., in pandanus swamp, near Nadgani in the Wynaad, about 900 m (no specimen in MH).

Ophiorrhiza pykarensis Gamble, erect and slender undershrub with small leaves and pale blue or lilac flowers, in a shola at Pykara Falls, rare, possibly extinct, about 1,900 m (not collected since the type collection).

Pavetta breviflora DC. var. *ciliolata* Gamble, Coonoor, Thai Shola and Snowdon R.F 1,500-2,100 m.

**Pavetta hohenackeri* Brem., glabrous shrub near Sispara, 2,200 m, rare (no specimen in MH).

RUTACEAE

**Melicope indica* Wt., shrub to small tree with opposite leaves, in sholas and near streams, fairly common, Avalanche and Kundahs, Toda hamlet of Koshti, Lakkadi (collected there by Shetty after 80 years), Sispara, 2,000-2,300 m.

SYMPLOCACEAE

**Symplocos microphylla* Wt., shrub on grasslands, tree in sholas, beyond Avalanche, Kudiakad, Sispara, Upper Bhavani to Bangihalla, 2,000-2,300 m (in MH).

Appendix 4: Record of Fires and Grassland Formation

Hough 1829: 72-73.

.... During the dry season, i.e. from December to May, they [Todas] burn the grass, which, in the darkness of the night, presents a grand spectacle, the sides of the entire hill being illuminated at the same time; but it greatly disfigures the scenery by day, as in a few hours a verdant mountain is transformed, in appearance, to a barren, sombre rock. This improves the grass for the buffaloes, making it coarse, and causing it to grow in tufts: but it is hereby rendered unfit for smaller cattle and sheep, of which, however, the Thodawurs [Todas] keep none....

Harkness 1832: 62.

After nightfall, the scenery around us was grand beyond description. Much of the grass, fern and heather, being frost bitten and withered, the Tudas [Todas] had taken this opportunity, before the setting-in of the rains, to fire it; and many of the ridges of mountains now presented an undulating and apparently endless line of flame.

Ouchterlony 1848: 56.

.... The grass upon which they [Todas] pasture their buffaloes is of coarse rank description, fit only for those hardy and powerful animals; but by burning it down, as is their practice, just before the rains set in, when they are about to migrate to another *mund* [common name for a Toda hamlet], a fine tender young grass, highly nutritious as pasture, has replaced the ashes of the old grass by the time they return to the *mund*, round which they have set their fires.

King 1870-71: 25.

.... During the dry season — that is, from the beginning of January to the end of April — they [Todas] are in the habit of setting fire to the grass, with a view of promoting its better growth; another Kaffir [African name for livestock keepers] custom, and one, moreover, the beautiful effect of which at night will be remembered by all who have ever seen it on so large a scale.

Marshall 1873: 53.

.... Wherever, in fact, rich soil and a perennial supply of moisture may be found, there are the ever silent woods; for the periods of annual drought are long: the monsoon rain flows quickly off the hard surface of the exposed hills, and the scorched grass containing the young saplings is yearly fired.

Duff 1876: 17

We waited to give the weather time to reconsider itself, but in vain, and then slowly descended [down the side of Mukerti Peak] ... and crossing great tracts of hillside over which a fire had just passed — the wasteful custom of burning the surface with a view to obtain a good bite of grass being in full force here.

Grigg 1880: 10.

.... It is, however, to be remembered that the present park-like appearance of the higher plateau, with its down and woodlands, is also, in a great measure, due to the annual recurrence of fires which sweep over the hills, burning the grass and outlying shrub and even the smaller sholas, and checking the larger woods in their persistent efforts to extend their domain further along the sides of the valleys.

Jennings 1881: 8-9.

The country [between Ootacamund and Neduvattam] is undulating and grassy, bare of timber except in such hollow places as afford the necessary moisture and shelter. In these spots there are lovely groups of trees, and often a delicious undergrowth of ferns — veritable oases in a desert of uninteresting slopes, covered at this season with burnt-up grass.

Francis 1908: 212.

In the case of the Kundahs and the Downs, an exception to the usual forest rules was made, after much discussion, in 1905, in that the annual burning of the grass was permitted. These areas are chiefly of value as great grazing grounds; and it was considered that burning was essential to the production of the young green grass so desired by the grazers and did no appreciable harm to the sholas as long as it was done early in the year while the undergrowth and bracken in and round them was still green and if precautions were taken to prevent the fire from spreading to an inflammable growth which ran up into them.

Champion 1935: 141.

In the dry season in February-March the grasslands get very dry and inflammable and the greater part of them are burnt annually. This has happened as far back as we have any information and has unquestionably exerted a very great influence on the present distribution of the very fine tender evergreen forest. Burning completely stops regeneration of practically every tree species except Rhododendron and every fire eats in a little all along the periphery of the sholas.... Grazers (Pastoralists) have occupied the plateau for a very long time and have burnt the grass for the sake of the early flush of new growth that follows a fire, and it is unquestionable that the forest occupies a far smaller proportion of the area than it once did.

Ranganathan 1938: 527-528.

Burning the grass is an immemorial custom of the Todas which has been officially recognized and is now being officially regulated.

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STATUS AND CONSERVATION OF THE WILD BUFFALO *BUBALUS BUBALIS* IN PENINSULAR INDIA[1]

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Most of the Wild Buffalo *Bubalus bubalis* populations in India have been genetically swamped out through inter-breeding with domestic populations. However, genetically pure species of the Wild Buffalo confined in the four protected areas especially set up for them in Peninsular India, for the last two decades, are their main hope. The population of the endangered Asiatic Wild Buffalo in Central India is restricted to two protected areas and their numbers are less than 75. The major reasons for the decline of Wild Buffalo population in peninsular India are agricultural encroachments, poaching, cattle grazing, insurgency and collection of non-timber forest produce. The population is under severe threat due to depletion of suitable swamp grassland habitat, large-scale poaching and communal hunting. Management interventions for long-term conservation of the Wild Buffalo were inadequate. Some suggestions are provided to improve the effectiveness of the conservation efforts in peninsular India to protect the existing populations of this species in the Indravati National Park and Tiger Reserve, and Udanti Wildlife Sanctuary.

Key words: Wild Buffalo, *Bubalus bubalis*, conservation, Udanti Sanctuary, Indravati National Park and Tiger Reserve

INTRODUCTION

The Wild Buffalo *Bubalus bubalis* is one of the largest and highly endangered land mammals in the Subcontinent. In the last bastion of the Wild Buffalo, Assam, the population is now almost confined to four protected areas. In Dibru-Saikhowa and Pabha Sanctuaries, the few surviving animals are affected by genetic "swamping out" through inter-breeding with the domestic buffalo; the population in Kaziranga has also been affected. There is a marked deterioration in size of the Wild Buffalo here in the last four decades, further confirmed by the markedly less pronounced occurrence of the characteristics which distinguish the wild from the domestic (Ranjitsinh 1997). In Manas, the laxity of control due to terrorist incursions in the past decade has resulted both in the reduction of numbers and in genetic swamping out in the much more numerous southern population, which will inevitably have an effect upon the rest of the herds in the adjacent central part of the Reserve — the Uchila Range and along the Manas-Beki River.

The main hope for genetically pure Wild Buffalo, therefore, lies in the peninsular population that has been confined for the last two decades in the four protected areas especially set up for them in Chhattisgarh – Udanti Sanctuary, Bhairamgarh Sanctuary, Pamed Sanctuary and the Indravati National Park and Tiger Reserve.

Genetic swamping out has not occurred here for various reasons – vast, very thinly populated malaria – infected forests, where tribals traditionally did not keep domestic buffaloes for fear of the female buffaloes being commandeered away and the domestic bulls killed by wild ones. Due to the great difference in size between the domestic and the wild, in cases where inter-breeding did occur in this area, it resulted almost invariably in the death of the mother or the calf, or both, at the time of birth. In Assam, the difference between the domestic and the wild buffalo is much less pronounced and progressively so with the initiation of genetic swamping. There are more domestic buffaloes than any other livestock species in the world. Their most common use is, significantly not as milch cattle, but as draught animals where size and strength are most important. Thus, the degeneration, let alone disappearance, of the wild buffalo through genetic swamping should be of particular concern, the animal being the most important large wild mammal in the world today, and vis-à-vis human welfare, an invaluable gene pool.

Earlier surveys (Mooney 1930, Daniel and Grubh 1966, Divekar 1976, Divekar *et al.* 1979, Divekar and Bhushan 1988) concentrated on the status and ecology of the species. Other studies focussed on the morphological features and behavioural characteristics of the species (Gee 1953, Inverarity 1895, Lall 1953, Noronha 1954a, b). The study of Daniel and Grubh resulted in the species being declared endangered and it was placed on the IUCN Red Data Book (1982). Even during the earlier surveys, the population of about 200 to 250 animals in 640 sq. km of the best buffalo habitat was considered to be low (Daniel and Grubh 1966). Considering the rate of habitat degradation in peninsular India and the time of last survey, which took place a decade back, a survey to assess the current status of Wild Buffalo and its habitat was realized and initiated.

STUDY AREA

Udanti Sanctuary

Udanti Sanctuary is situated in the Raipur district of Chhattisgarh State of India. The habitat of the Sanctuary is representative of mixed dry deciduous forest (Champion and Seth 1968). Some important woody plants are *Shorea robusta*, *Diospyros melanoxylon*, *Buchanania lanzan*, *Terminalia tomentosa*, *Anogeissus latifolia*, *Stereospermum suaveolens*, *Pterocarpus marsupium*, *Cassia fistula*, *Ougeinia oojeinensis*, *Madhuca indica*, etc. Almost the entire ground is covered with grasses. *Heteropogon contortus*, *Imperata cylindrica*, *Bothriochloa odorata*, *B. pertusa*, *Dichanthium annulatum*, and *Themeda quadrivalvis* are the major grass species, which are disturbed by humans as well as overgrazed by domestic cattle. The Sanctuary is mostly flat, but the northern part is hilly. The main drainage system is the Udanti river and its tributaries. The Udanti river is not perennial, but small pools always retain water even in summer. Soil in this region is generally loamy and well drained. Gonds, Bujjia and Umar are the major tribes living in these areas.

Indravati National Park and Tiger Reserve

The Indravati National Park is situated in the districts of Bastar and Dantewada of Chhattisgarh State. The habitat of the Park is mixed deciduous forest interspersed with various open pockets of abandoned arable land (Champion and Seth 1968). Some important woody plants are *Diospyros melanoxylon*, *Buchanania lanzan*, *Tectona grandis*, *Terminalia tomentosa*, *Anogeissus latifolia*, *Stereospermum suaveolens*, *Pterocarpus marsupium*, *Cassia fistula*, *Ougeinia oojeinensis*, *Cleistanthus collinus*, and *Gmelina arborea*. Hill slopes and riverbanks are covered with bamboo *Dendrocalamus strictus*. However, the vegetation varies from place to place (Pandey 1988). Most of the grasslands, which are the result of abandoned arable lands and accumulation of water in shallow 'troughs' in the monsoon, are the ideal habitats for wild animals. Due to prevailing successional stages, these patches are being encroached on by woody plants as a result of compaction of soil due to repeated fires and trampling by livestock. There was no appreciable growth of *Ficus* sp., which might be due to edaphic factors. The dominant grass species are *Heteropogon contortus*, *Imperata cylindrica*, *Bothriochloa odorata*, *B. pertusa*, *Dichanthium annulatum*, *Themeda quadrivalvis*, *T. triandra*, *Eragrostis* spp., *Chrysopogon fulvus*, and *Vetiveria zizanioides*. Wild Buffalo preferred *Cyperus corymbosus*, *Cynodon dactylon*, *Themeda quadrivalvis*, and *Coix* spp., among others.

In both the protected areas, as in the rest of India, there are three distinct seasons. The temperature, humidity and precipitation vary so greatly that they regulate the growth of vegetation and also the habits of the wild animals. Rain commences by the second week of June and continues till September. The average rainfall was 182 cm. The highest temperature (45 °C) was recorded in May 1973 and the minimum (2.8 °C) was recorded in January 1945 at Jagdalpur. Humidity is between 22% and 87%. Wind velocity is maximum in July and minimum in January. During the survey period, the maximum temperature was about 43 °C.

METHODS

Udanti Sanctuary

Udanti Sanctuary was surveyed from May 10-13, 2000. The survey was carried out in all the forest compartments (water pools and forest roads) where wild buffaloes were reported earlier. A 100 x 1000 m (10 hectare) transect was laid for estimating the Wild Buffalo population by looking for dung density as well as hoof marks. To avoid confusion while differentiating hoof marks, the size (length and width) of the hoof marks of both wild and domestic buffaloes were measured after sighting the animal directly. Any hoof marks larger than 14 x 13 cm were considered as that of the Wild Buffalo.

Indravati National Park and Tiger Reserve

The Indravati National Park and Tiger Reserve was surveyed from May 14-17, 2000. The survey commenced from Bijapur and ended at the same place via Somanpalli, Pharsegarh (night halt); Pilur, Jalavagu, Sopmarka, Badekakler, Chhotekakler, Arepalli, Sendra, Mattimarka (on the Indravati River and a halt on an island); Sendra, Pengunda (night halt); Netikakler, Karkawada, Godnugur, Durepalli and Kutru. During the survey, we checked most of the artificial water pools, visited the areas where Wild Buffalo were sighted earlier and had discussions with the people of the area.

RESULTS AND DISCUSSION

In the two protected areas, Udanti Sanctuary and Indravati National Park and Tiger Reserve, where the wild buffalo still survives, this survey was able to assess about 42-44 buffaloes in Udanti and 25-30 buffaloes in Indravati, the total number being less than 75. In the Indravati National Park, the population is split into three disparate clusters, with possibly little or no inter-breeding, giving rise to a spectre of severe inbreeding amongst the three separate clusters. These three clusters are:

1. **The Salepalli – Pillur cluster**: Comprising a solitary bull and a herd of five to six animals. This is in the southeastern part of the Park.

2. **The Tekmetta cluster**: Comprising a solitary bull and a herd of five to six animals. This is in the southwestern part of the National Park, which is the remotest and least disturbed part of the Park. It is comprised of hills and valleys adjoining the eastern flank of the Indravati, providing the most disturbance free habitat with the most readily available access to perennial water — the Indravati. Significantly, however, the hilly terrain is not a particularly suitable habitat for the buffalo. Here, we assessed the presence of 10-15 animals in three or four groups as well as solitary individuals. This area, which is the site of the proposed Bhopalpatnam dam, holds the best hope for the survival of the Wild Buffalo in the Indravati National Park.

3. **The Pengunda – Netikakler cluster**: Comprising nine animals; one solitary, a herd comprising of a bull, two adult cows, a sub-adult and calf, and another group of a cow, sub-adult and calf. This cluster is in the northeastern part of the Park.

The extent of persecution of the buffalo was evident from the behaviour pattern of the animals. Wild Buffaloes are highly averse to human disturbance and have sought refuge in the remotest habitats, the solitary bulls that seek domestic buffalo for mating being an exception. In both Indravati and Udanti, wild buffaloes have become entirely nocturnal from their normal diurnal habits. They seek the remotest forests for daytime resting, travelling long distances from their feeding ground. What is more, they appear to have forsaken their usual midday immersion in water and a drink of water, even during the height of summer. Even at night, they now avoid artificial tanks, such as the Modakvaya near Pengunda, frequented by livestock and fishermen, preferring to skirt the tank to walk six or more kilometres each way each night in summer, to reach the safe and quieter Indravati river and then back to their feeding grounds. The survey team could see only one solitary bull, of the Tekmetta cluster, at 0430 hrs after waiting the whole night on an island in the Indravati. It had come for an early morning drink before lying up for the day. Fresh footprints of all the three clusters of buffaloes were seen.

In Udanti Sanctuary, the Wild Buffalo population is now restricted to a very small area of 80 sq. km, possibly because of the persistent habitat disturbances. In all, seven Wild Buffaloes were sighted between 1800 and 1900 hrs on May 12, 2000 and the next day. Of these, one was a solitary bull and others were in a herd, comprising two adult females, one adult male, two yearlings and a calf about one month old. Seven more Wild Buffaloes were also identified on the basis of hoof marks near the water pools and the transect area. Since domestic buffaloes were present throughout the Sanctuary, there were limitations to differentiating the hoof marks between wild and domestic buffalo. All the water pools had old and dried (hardened) hoof marks of both domestic and wild buffalo. Transect counts confirmed the presence of at least two herds of Wild Buffaloes based on hoof mark tracing and dung cakes (wild buffalo having larger dung cakes). Four fresh and 19 old dung cakes were observed in the 10 hectare transect area. However, small sized dung deposits provided confusing results, as young ones of Wild Buffaloes may have deposited the smaller dung cakes. Dung and hoof mark counting may be a good method for estimating the status of Wild Buffaloes if the area is devoid of domestic buffaloes. The team could hardly come to a definite conclusion on the population size.

Secondly, information collected from the local and forest field staff revealed that the number of Wild Buffaloes range between 42 and 44. Demography of known herds shows that there was good recruitment in this population.

The normal behaviour of the wild buffalo in this sanctuary has changed. A herd arrived at the pond for drinking water at 1805 hrs in the Nagesh Tank. They spent around 50 minutes in the pond area. During this period, they browsed in the nearby grassy patches and wallowed in the pond. The one month old calf always remained near its mother. The entire herd remained together and some of the members were vigilant and constantly looked around. The herd was alert and under stress throughout the observation period and this can most probably be attributed to human disturbance. A huge solitary bull sighted by the team was standing under a *Diospyros melanoxylon* tree at 1855 hrs and staring at the team's vehicle, though it made no move. A few minutes earlier, it had caused a forest guard to seek safety up a tree, from where he was rescued by the survey team.

People

Of the 80 families living in Karlajhar and Nagesh villages in Udanti, approximately 50 people participated in the discussion with us. Gonds, Bhujjia and Kamar are the major tribes living in these villages. Generally, these people are farmers raising kharif crops and they keep a large number of cattle, which are reportedly unproductive. During the summer season, they are engaged in non-timber forest produce (NTFP) collection, mainly tendu *Diospyros melanoxylon* leaves and also earn income through road construction, deepening of village ponds, as forest firewatchers. They revealed that there are no good schools, transport or medical facilities near by. Although they showed keen interest in the conservation of the wild buffalo, they complained that the occasional raid of their crops by wild buffaloes, especially kulthi and madia, two locally grown pulses, affected them. They realised that the population of the wild buffalo is decreasing. However, they were unable or unwilling to give reasons for this decline.

Indravati National Park holds resident populations of three tribal groups, namely Gonds, Marias and Murias. They generally depend on monsoon-based sustenance agriculture and plant kharif crops, besides keeping a large number of livestock including some buffaloes. They are also hunters, and hunt almost all the wild vertebrates using nets, traps and indigenous weapons, such as axe, spear, bow and arrow. We noticed unrestricted movement of the people inside the protected areas (PAs) armed with bows and arrows. They also perform communal hunting (*Paradh*) when people from one or more villages get together and flush out all the wild animals towards a long chain of nets raised on bamboo poles. Forest officials and the survey team stopped one such big *Paradh* while returning from Karkawada to Kerpe on May 17, 2000. The team seized seven nets (a net = 2 x 10 m in size) and bamboo poles, axe and spear from the hunters. Approximately 40 people, including some young boys, were involved in the *Paradh*. During the summer, apart from hunting, the local people are engaged in collection of Non Timber Forest Produce (NTFP), mainly tendu *Diospyros melanoxylon* and mahuwa *Madhuca indica*. Although the income from this is estimated to be less than Rs. 200/capita/annum, the disturbance and damage caused has adverse effects on the entire tract of the protected area (PA). Unavailability of work and unrestricted movement inside PAs during summer has led the people to engage in large scale hunting. The negative perception about conservation of wild buffalo and other wildlife is due to possible attack from these animals. In the past, there were incidents of conflict between humans and the wild buffalo. On May 2, 2000, a solitary wild buffalo bull killed one person near Phulgundam village.

Availability of Water

In Udanti Sanctuary, water is retained in a few pools in the Udanti river in summer. There are four artificial tanks spaced out in the main Wild Buffalo habitat, which also retain water in summer. However, the presence of domestic buffaloes and other livestock deters the Wild Buffalo and other animals from utilizing almost all the water sources barring two, during daylight.

Indravati National Park and Tiger Reserve is a high rainfall area. However, the soil being porous sandy loam its water retention capacity is low. In the past, depressions and troughs in the soil enabled accumulation of shallow water and growth of marshy grasslands suitable for animals like the Wild Buffalo and the Barasingha. Incessant fires have not only destroyed the grass, especially the more palatable perennial *Andropogon* varieties, but also led to the hardening of the soil, which is further compacted by the hoof marks of livestock attracted by the flush of grass following the burning. Gradually, the marshy grasslands have become hard ground covered by short, annual, less nutritious *Heteropogon* grasses, gradually being overtaken by tree growth.

What was indeed most surprising was the lack of perennial water. The Indravati river, circumscribing as it does a loop covering two sides of the Protected Area, is the only natural perennial water source. In the rest of the vast area, there are a few artificial tanks and a few pools in the Davil Vagu and Kaker river, all occupied by livestock in summer. Even in the Pillur tank, there were no recent Wild Buffalo hoof prints to be seen. The lack of water during the peak of summer is a major drawback for wildlife in the Indravati National Park. It also facilitates ambush at water holes and *Paradh* operations.

Threats and Recommendations

The following adverse factors and threats were observed and perceived:

1. Communal hunting called *Paradh* is universally practised throughout Indravati National Park, persistently and methodically in the dry season. No animal is safe from this operation.

2. Fire, mostly repeated fires, were seen to have affected about 95% of the National Park. This deliberate burning is for *Paradh*, collection of the NTFP, especially tendu leaves and for grazing purposes.

3. Extensive grazing and related fires, and disturbance, habitat degradation and threat of contagion of livestock-borne diseases. However, the livestock population in itself is not high and there are few domestic buffaloes even now.

4. Extensive and continuous anthropogenic disturbance.

5. Existence of 53 villages, though small in population, spread all over in a jig-saw puzzle formation, have an overall adverse impact. Almost all are revenue villages.

6. Lack of adequate number of permanent waterbodies. Barring the Indravati, all existing water points pose a danger to wild animals in summer.

7. Presence of Naxalites. Though these groups are largely pro-forest and pro-wildlife, their occurrence in the Indravati Tiger Reserve is both the reason and an excuse for many failings in management. Wireless sets have been snatched in 1988, government buildings destroyed, culverts and roads not allowed to be built and the Field Director attacked.

8. Routine patrolling and law enforcement is thus greatly hampered and a fear psychosis affects the staff.

9. Lack of adequate and appropriate manpower and infrastructure support, resulting in failings in management.

Conservation measures

1. Final notification of the Indravati National Park and Tiger Reserve must take place immediately. It has been proposed to extend the National Park over uninhabited forests southeast towards Bijapur. Those portions of the Indravati National Park which are Reserved Forests, together with the Reserved Forest portions of the proposed extension mentioned above, can forthwith be declared a national park as no acquisition of rights proceedings are required.

2. NTFP collection for non-commercial use only should be continued, as per the management plan, in the sanctuary portion only. All NTFP collection for commercial purpose must stop forthwith in these PAs.

3. An updated management plan has to be prepared for the Indravati Tiger Reserve and the Udanti-Sitanadi Protected Areas complex.

4. In view of the severe pressures being inflicted upon the surviving Wild Buffalo in Indravati National Park, the Udanti-Sitanadi population assumes additional importance. A 'corridor' linking Udanti and Sitanadi Sanctuaries has long been proposed. This must be established in the form of a sanctuary extension and the Udanti-Sitanadi Complex together with the 'corridor' be managed as one ecological entity.

5. The Reserved Forests of Udanti south of the Raipur-Deobhog Road and at least the adjacent reserved forest of the eastern parts of the Sitanadi Sanctuary which have no habitations, together with the uninhabited Reserved Forests of the proposed corridor, should become a national park, and the rest finally declared as a sanctuary.

6. Fire application and long lines of strong, high nets during *Paradh* must stop. While the authorities must show determination to stop this at any cost, persuasion and alternatives should also be proferred. The pujaris of various villages should be persuaded to change over to symbolic *Paradhs* in the form of a ritual and the meat requirements, in the form of live buffaloes and goats, could be provided by the Park authorities. It is certainly worth attempting.

7. The Wild Buffalo needs large tracts of undisturbed forests with grassy openings, preferably moist and marshy patches, and close proximity of perennial water. This must be ensured in all management applications and the disturbance factor must not be ignored.

8. Currently, the 19 km stretch of the Indravati river extending from below Bendrai Gutta hill to above Mattimarka village, constituting the border between Maharashtra and Chhattisgarh, happens to be the most remote and uninhabited stretch of a river anywhere in Chhattisgarh and there are no habitations in the adjacent forests which comprise of the Kutru Reserved Forest. This tract with its frontage on the Indravati is the most promising habitat where a last ditch effort can be made, as the focal point of protection efforts and inputs, including constant monitoring. This area affords perhaps the last hope of saving the peninsular Wild Buffalo.

9. The 53 existing villages within the Indravati National Park and others in the buffer area are encroaching upon forests and expanding their cultivation illegally. These encroachers must be evicted.

10. In view of the grave danger of extinction as well as genetic degeneration through interbreeding with domestic buffaloes, the peninsular buffalo may be the only hope for the survival of the pure strain of Wild Buffalo. A special project should be started jointly by the Central Government and the State Governments of Chhattisgarh and Maharashtra, to define and implement immediate and long-term actions. A special fund would have to be provided by the Central Government, but the infrastructural, logistical and other support and inputs would have to come from the two States. Subsequently, if the buffalo numbers increase and some movement of wild buffaloes to Orissa and Andhra Pradesh occurs, these States should also be involved.

11. The buffaloes in Indravati National Park are in three distinct clusters, as mentioned. Three small protection units or special parties need to be established, each under a selected forester or deputy ranger and comprising of local persons of knowledge and commitment, whose sole job would be to save these three clusters of wild buffalo and their habitat from

poaching, harassment and fire. They would continuously monitor the movements of the animals and would be personally responsible for their safety. The units must be adequately equipped, regularly supervised, and rewarded when successful in their work.

12. Traditionally domestic buffaloes are not kept in Wild Buffalo habitats, a trend to be encouraged and domestic buffaloes relocated outside the main buffalo habitats in the Indravati, and from Udanti in particular.

13. Paucity of water in peak summer is a serious drawback. However, the tanks that have been made have been so disturbed by man and livestock that wild buffaloes do not use many of them, Modakvaya lake being one example. These remote tanks meant for wildlife away from human habitations must be kept free of human disturbance.

14. Fire, which is deliberate, universal and repeated, must be controlled. Stoppage of *Paradh* and the commercial collection of NTFP would itself reduce the incidence of fire greatly. For the rest, incentives to the locals would have to be given annually on performance in both putting out and preventing fires.

15. Dialogue with the locals, their leaders and even the 'Naxalites' to convince them of the reasons of management actions and, to ascertain and provide the genuine basic requirements of the local people, including alternatives. Their participation in conservation action must be obtained to the extent possible, and in this endeavour NGOs like the Bastar Society for Conservation of Nature (BASCON), would be most helpful.

16. While no coercion need be done, inhabitants of the smaller and more remote of the 53 villages within the Park can be approached to ascertain whether they would wish to resettle either outside the Park, or even move over to a larger village within it. The attempt should first be made in the habitats of the three remaining clusters of wild buffaloes. Those habitations that wish to move should be given an option of where to go, given one and a half times the land that they legally possess and other compensations, and be provided vehicular transport to shift their belongings. But it may be ensured that an entire habitation is shifted, not just a few members of it, and after shifting they should not come back and take possession of their previous holdings as well. This is a very sensitive issue and should only be attempted in cooperation with the local leaders and politicians.

17. Eco-development should be taken up in the buffer area of the Park, the aim being to reduce the biotic pressure, and move away from the Park by providing alternatives.

18. An anti-poaching camp should be posted at Pharsegadh for Indravati and provided with mini-trucks. Park staff, including forest guards, should be trained in the wildlife guard training school at Bandhavgarh.

19. Prophylactic inoculation is done sporadically in pursuance of the Supreme Court orders. This must be more regular and widespread.

20. Continuous monitoring and applied research to assist management and ensure a scientific presence, involving local universities and institutions.

21. Coordination and regular contact between the field management personnel in adjacent areas of Madhya Pradesh, Maharashtra, Orissa and Andhra Pradesh.

22. The Bhopalpatnam dam site is almost in the centre of the 19 km stretch of the Indravati. If the dam is allowed, it will mean the destruction of this magnificent habitat and of the last hope of the survival of the buffalo in the Indravati National Park and Tiger Reserve.

23. The Udanti-Sitanadi complex is under the threat of mining. This must be prevented at all cost and this complex of PAs with the corridor in between and suitable adjacent areas should now be made into a Tiger Reserve under Project Tiger.

24. As a safeguard against extinction in the wild, a capture, translocation or captive breeding/reintroduction programme may have to be contemplated, as a last resort. A suitable site would be the large enclosure in Sukhpar, Kanha National Park, which could then be a haven for the species. In any case, expertise would have to be developed within the Indravati National Park management to enable transquilisation, treatment and local translocation of Wild Buffalo which might have been wounded, or where it may be necessary to shift unsafe or single animals from one part of the Park to another.

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UNREPORTED APPEASEMENT BEHAVIOURS IN THE ASIAN ELEPHANT (*ELEPHAS MAXIMUS*)[1]

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Limited detailed information is available on the social behaviour of the Asian Elephant. This paper describes hitherto unreported submissive behaviours exhibited by captive Asian Elephants. These behaviours are rare and have only been observed on a small number of occasions during over 400 hours of observations made over two and a half years. When approached by an adult bull, some adult cows were observed to decline the head and bow down, lowering the head to ground level. This occurred when the bull was in musth, or when he had been separated from the cows for many days. On other occasions, cows kneeled on the rear legs and, in extreme cases, lay prone. A cow was also observed bowing low to a very young calf soon after birth and when his mother was far away. This behaviour may have been intended to reassure the calf that the cow was not a threat. The appeasement of aggression by submission to ritualised mounting was also observed. These behaviours are similar to those observed in some mammalian species, particularly ungulates.

Key words: *Elephas maximus*, elephant, appeasement, behaviour

INTRODUCTION

Ritualised appeasement behaviour is known from a wide range of mammalian species and includes exposure of vulnerable parts of the body, lowering of the head and body, lying down, sexual presentation, and submission to mounting (Ewer 1973).

Early descriptions of aggression in elephants were concerned with the fighting behaviour of adults (Carrington 1958; Kühme 1961, 1963). Estes (1991) has categorised defensive/ submissive displays in African Elephants (*Loxodonta africana*) as: avoidance (turning away, backing up, running away), flattening ears, arching back, raising tail, agitated trunk movements, touching temporal gland, throwing dust, pawing, foot-swinging, swaying, and exaggerated feeding behaviour. In an agonistic encounter between two bulls, the smaller animal flattens its ears, keeps its head lowered, moves backward and sideways and makes writhing trunk movements.

Langbauer Jr. (2000) has summarised apprehension and submissive behaviour in elephants as: jaw out, face check, trunk twitch, trunk curl, swaying, tail up, back in (Kühme 1961; Douglas-Hamilton 1972; Payne and Langbauer Jr. 1992; Poole 1999).

This paper describes hitherto unreported submissive behaviours exhibited by captive Asian Elephants. They include declining the head, bowing the head low to the ground, kneeling on the rear legs, lying prone and submission to ritualised mounting. These behaviours are rare and have only been observed on a few occasions. However, similar behaviours have been observed in other mammal species (Estes 1991).

Head held low is a submissive posture in Buffalo (*Syncerus caffer*), Giraffe (*Giraffe camelopardalis*), Rhinos (*Diceros bicornis* and *Ceratotherium simum*), Warthog (*Phacochoerus aethiopicus*), zebras and asses (Equidae), and is almost universal in the antelope species (Bovidae). Subordinate Chimpanzees (*Pan troglodytes*) have been observed bowing to alpha males (de Waal 1996). A kneeling posture, representing an intention to lie down, occurs in the Black Wildebeest (*Connochaetes gnou*), however, in some species, kneeling is associated with aggression or dominance. Bull Buffaloes (*S. caffer*) kneel, and rub the face and chin on the ground in an aggressive display. Pfeffer (1967) has described an appeasement ceremony in the Mouflon (*Ovis ammon*), which consists of the superior animal kneeling to be licked by the inferior. Lying-out (lying prone) occurs in *Connochaetes* and in Sable (*Hippotragus niger*). Lowering the hindquarters is a submissive behaviour in the Spotted Hyena (*Crocuta crocuta*) as is lying prone in the Brown Hyena (*Hyaena brunnea*) and in hippos (*Hippopotamus amphibius*), resembling the posture of oestrus females during copulation. Ritualised mounting by dominant animals is well known in primates, e.g. baboons (Cercopithecidae) (Colmenares 1991).

METHODS

The subjects of this study were members of a herd of Asian elephants held at the North of England

Zoological Society's National Elephant Centre (Chester Zoo) in Cheshire, England. At the beginning of the study, the herd consisted of one adult (tuskless) bull, 5 adult cows, a juvenile bull and a calf. Two calves were subsequently born in 2000 (Table 1).

During the day, the herd was confined within an outdoor enclosure surrounded by a dry moat. At night, the animals were housed in an elephant house in which the adult bull was kept separate from the others. Sometimes the adult bull was confined to a separate bull pen during the day. This meant that on occasions the bull and cows were kept completely separate for many days, apart from brief contacts through steel bars.

Data on appeasement behaviour were collected *ad libitum* during a long-term study of the social dynamics of the herd. The herd was observed for a total of 420 hours on 93 days over two and a half years, between the beginning of January 1999 and the end of June 2001.

Most of the observations were made while the elephants were outside. All instances of unusual behaviour were recorded by typing descriptions into a Psion Series 5 handheld computer, and, where possible, by still photography (using a 35 mm camera with a 200 mm or 300 mm lens) and on videotape (using an 8 mm Sony Handycam SC5).

RESULTS

Observations of novel appeasement behaviour made during this study are summarized in Table 2. The most significant elements of this behaviour are ritualized bowing, kneeling on the rear legs, and lying prone. In addition, observations of submission to ritualised mounting behaviour are described. Some, but by no means all, of this behaviour occurred when the adult bull was in musth.

Ritualised bowing

Adult cows were sometimes observed to decline the head slightly in the presence of the adult bull. During this behaviour, the cow sometimes rubbed her head against his.

In extreme cases, the cow bent down to the ground with one leg tucked under the body, lowering the head to the ground (Fig. 1, 2a). During this behaviour the bull was sometimes seen touching the cow with his trunk and head. On two occasions, bowing behaviour by adult cows to the adult bull was exhibited after an extended period of separation from the bull.

The bowing behaviour was also exhibited by Sheba the adult cow towards the calf PoChin (Fig. 2b). In this context, she may have been signaling the absence of a threat to the calf. Sheba was the only adult in the herd that did not show aggression towards the young calf (usually kicking) during the first few days of his life, apart from his mother. Sheba appeared to exhibit this behaviour when the calf needed reassurance e.g. immediately after birth, when separated from his mother by a long distance, and on his first day outside the elephant house. Sheba acted as an allomother to PoChin from birth by guarding him (especially when asleep) and allowing him to comfort suckle.

Kühme (1963) described kneeling behaviour in captive African elephants, which occurred at the end of a hostile encounter. The appeasing elephant would kneel with ears spread wide in front of its partner, or a dog or a hostile human.

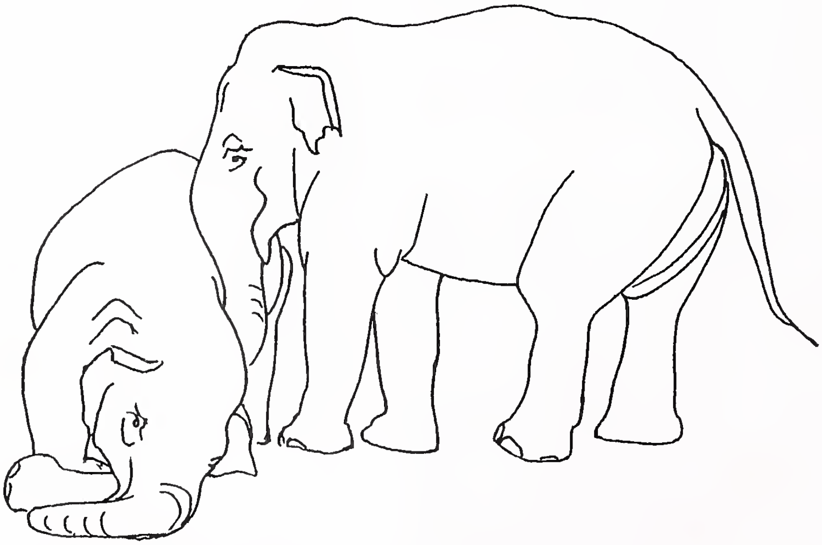


Fig. 1: Kumara bowing to Chang (based on Fig. 2a and other photographs taken during the study)

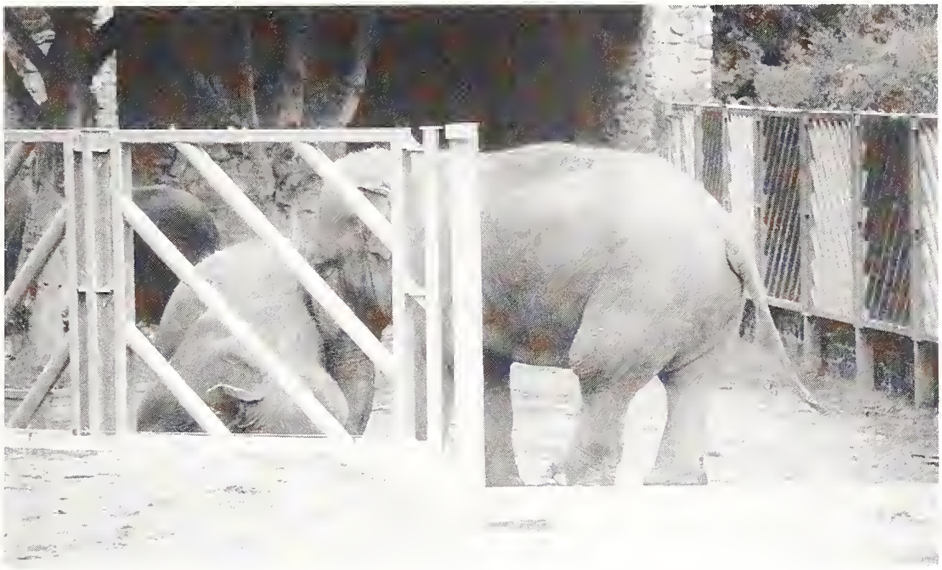


Fig. 2a: Kumara bowing to Chang while he was in musth (First recording of this behaviour)

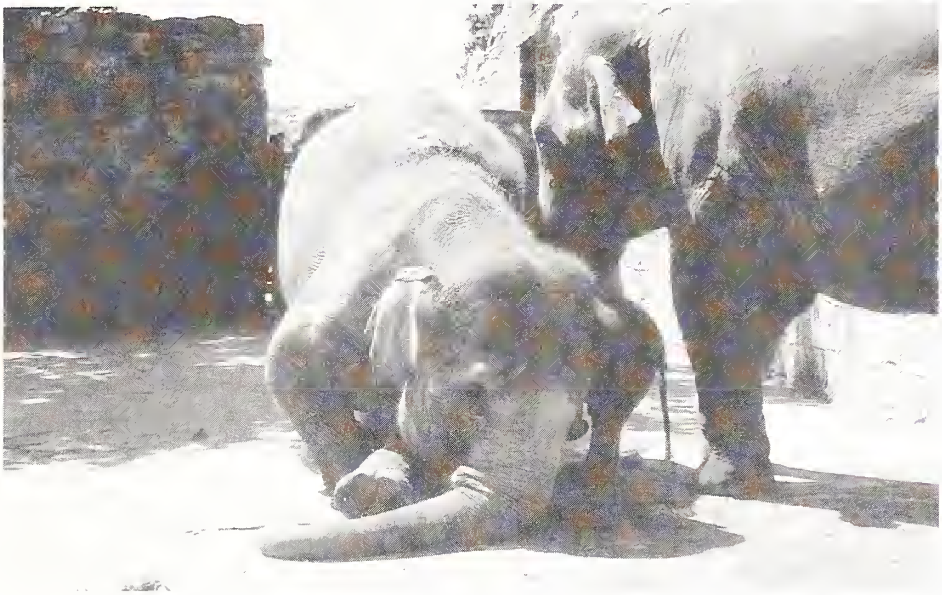


Fig. 2b: Sheba bowing to PoChin with his mother, Jangoli, standing nearby

Table 1: The composition of the elephant herd at Chester Zoo

Name/relationship	Origin/Place of birth	Sex	Approximate year of birth	Reproductive status during the study
Chang	Copenhagen Zoo	♂	1981	Proven bull
Sheba	Wild caught / Sri Lanka	♀	1956	Cycling
Thi	Logging camp / Burma	♀	1981	Pregnant/nursing
Kumara	Wild caught / unknown	♀	1966	Non-cycling
Maya	Wild caught / unknown	♀	1968	Non-cycling
Jangoli	Wild caught / Burma	♀	1967	Pregnant/nursing
Upali	Zurich Zoo	♂	1994	Juvenile
Sithami (Chang x Thi)	Born Chester Zoo	♀	1997	Calf
PoChin (Chang x Jangoli)	Born Chester Zoo	♂	2000	Calf
Assam (Chang x Thi)	Born Chester Zoo	♂	2000	Calf

Table 2: Novel appeasement behaviours observed within the herd

Date	Time	Stimulus	Subject animal	Kneeling on rear legs/ crouching	Slightly declined head	Kneeling on forelegs	Bowing low to the ground	Lying prone	Head rubbing	Rump held in mouth	Bull in mush	Notes
1.10.99	10.58	Chang?	Kumara	■							Yes	First record of bowing behaviour. (Fig. 2a)
	11.10	Chang	Kumara				■		■			
	13.30	Chang	Kumara	■			■					
4.11.99	12.13	Chang	Kumara	■							Yes	Began with greeting ceremony. Kumara urinated
2.8.00	10.33	Chang	Kumara			■	■				Yes	Bull and cows previously separated for about 15 days (Figs. 4a-d)
	11.15	Chang	Kumara		■				■			
	11.24	Chang	Kumara		■					■		
	11.29	Chang	Kumara					■				
28.11.00	a.m.	Chang	Sheba				■ (x2)				No?	First contact between Chang and herd for many days. Sheba facing Chang inside house
21.9.99	11.15	Chang/ Upali	Maya	■				■			No	Upali attacking Maya. (Figs. 3a-c)
14.7.00	13.53	Upali	Sheba	■							n.a.	Upali had violently attacked Thi earlier
18.7.00	14.30?	PoChin	Sheba				■*				n.a.	Night of PoChin's birth. Jangoli present. Keepers present
20.7.00	?	PoChin	Sheba				■				n.a.	In corral. First day outside. PoChin suckling from Sheba. Jangoli near.
2.8.00	14.46	PoChin	Sheba				■				n.a.	PoChin suckling from Sheba
4.8.00	11.17	PoChin	Sheba				■				n.a.	No other adults present. Mother approx 80-100 m away. Longest distance mother seen from calf to date
	11.21						■					
	11.25						■					
6.9.00	a.m.	PoChin	Sheba				■				n.a.	In elephant house. Keepers near

*	bowed low to ground repeatedly when the calf was less than an hour old.
n.a.	not applicable
?	time unknown or uncertain

Kneeling on rear legs and lying prone

When approached by a bull from the rear, adult cows sometimes crouched or kneeled on one of their hind legs in a posture resembling that adopted during courtship immediately before allowing mounting (Figs 3a-c). This may be a ritualised sexual submissive behaviour. In extreme cases, the cow lay down briefly in a prone position and then stood up (Fig. 4d).

Elephants rarely lie down on the ground, and then usually on their side. Lying prone is not a posture that elephants normally adopt when resting, so it is reasonable to assume that this behaviour has a special significance as a signal to others.

All the incidents involving the appeasement of Chang by the adult cows Sheba and Kumara using this behaviour occurred either when he was in musth (and in a more aggressive state) or after a prolonged period of separation from the cows. Under these circumstances, it might be expected that submissive individuals would need to confirm their status to a dominant animal.

The most impressive sequence of submissive behaviour was recorded from Kumara in response to the presence of Chang on August 2, 2000 (Table 3 and Figs 4a-d). This incident began with Kumara declining her head when Chang approached and culminated in her lying prone briefly as he walked behind and away from her.

Submission to mounting

On two separate days, the adult cow Kumara was observed submitting to mounting by the adult bull Chang while his penis was sheathed. These mountings were associated with aggressive behaviour.

Incident 1 (February 19, 1999): Chang and Upali pursued and pushed Kumara for a period of 24 minutes. After harassing her for eight minutes, Chang mounted Kumara with his penis sheathed. Fourteen minutes later, after holding her down on the ground, he mounted her again with his penis erect, but failed to penetrate her. During the incident Kumara vocalised frequently, defecated and urinated three times each, including during and after both mountings.

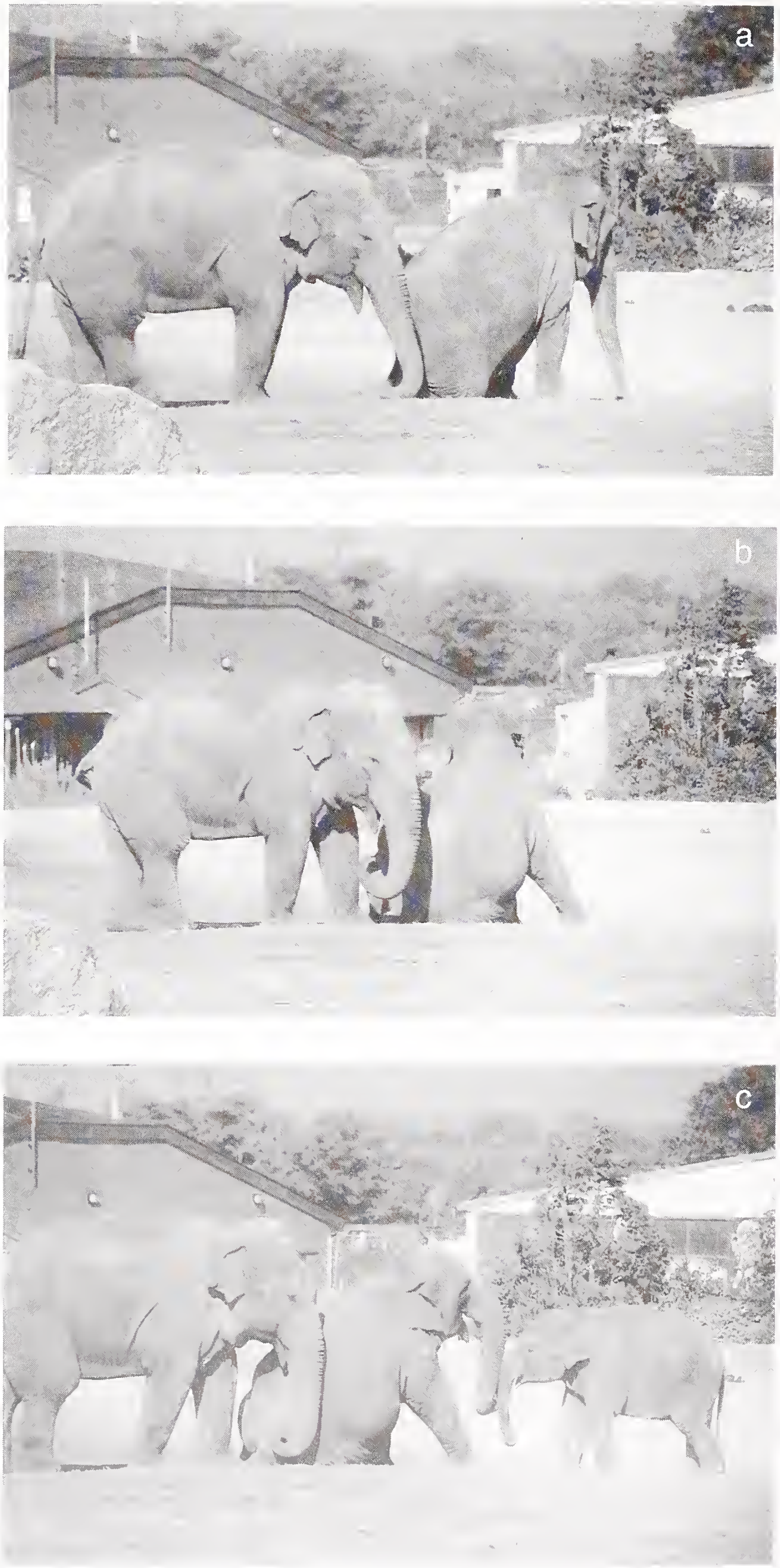
Incident 2 (February 28, 1999): Over a three hour period, Chang intermittently pursued and pushed Kumara. Chang mounted her twice with his penis sheathed (with an interval of approximately one hour). After the second mounting Upali attacked Kumara, and Jangoli attempted to intervene by obstructing Chang. During the incident Kumara vocalised five times, and urinated seven times, including during both mountings. After the first mounting, Kumara also defecated.

In the other 59 adult mountings observed, Chang's penis was always descended prior to mounting and erect during attempts at intromission. During normal sexual behaviour cows did not usually vocalise, urinate or defecate during courtship.

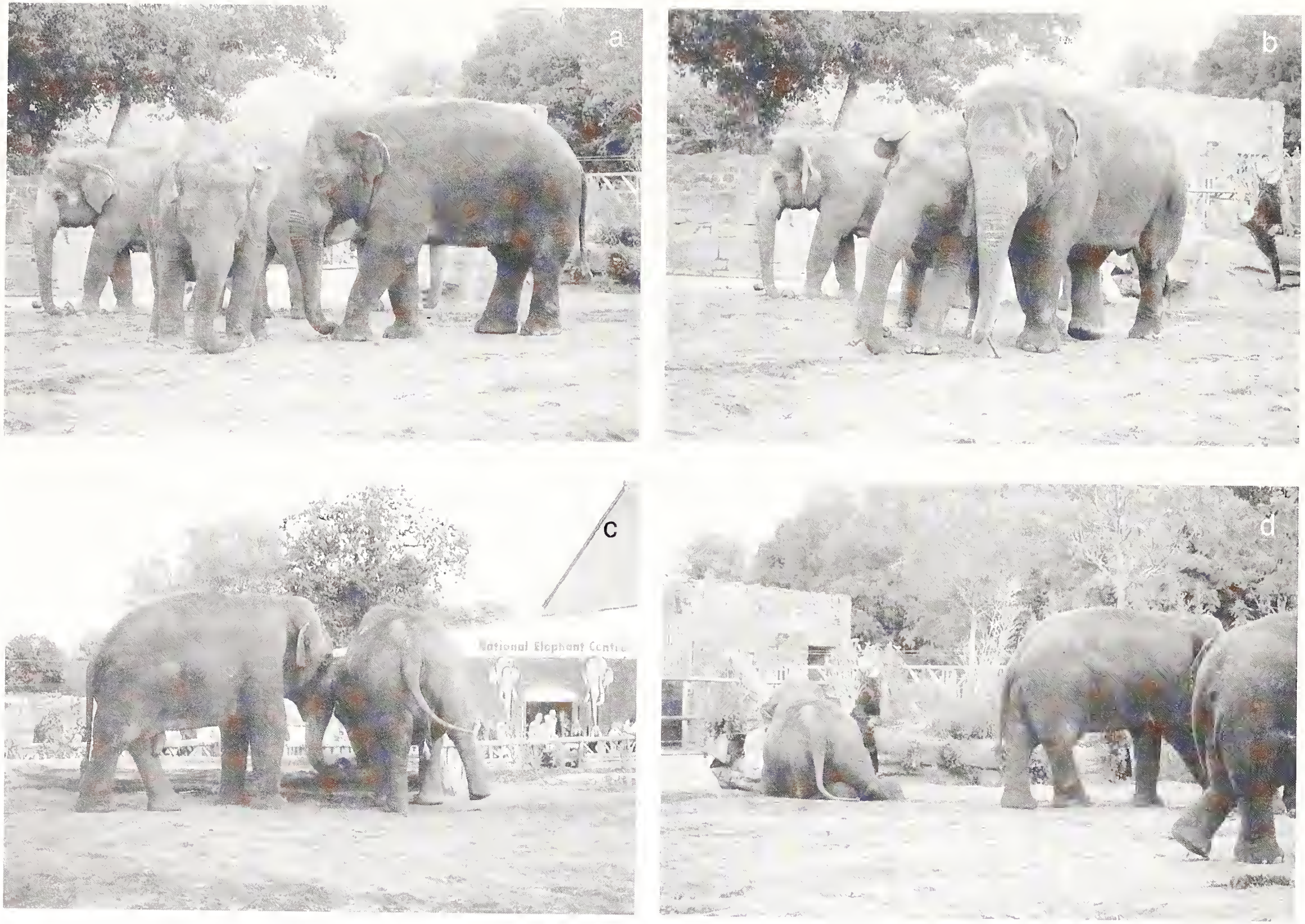
The aggressive behaviour exhibited by Chang during these encounters with Kumara suggests that these mountings were not sexual in nature and may have been a display of dominance. Kumara's allowing him to mount may have been an expression of submission. This interpretation is supported by historical evidence of the relationship between the two animals.

Table 3: Appeasement behaviour exhibited by Kumara towards Chang (August 2, 2000)

Time	Chang's interaction with Kumara	Chang's interaction with other herd members
10.00		Slight aggression towards PoChin
10.22		Mounted Sheba, kicked PoChin
10.26		Mounted Sheba
10.33	Kumara took part in greeting ceremony, then kneeled on front legs and bowed to Chang	Greeting ceremony with herd members
10.37		Chang kicked PoChin
11.10		Chang inspected Sheba's genitals
11.15	Kumara declined head to Chang, and rubbed her head against his (Fig. 4a and b)	
11.22		Chang inspected Sheba's genitals
11.24	Kumara bowed to Chang (Fig. 4c), then he withdrew	
11.27	Chang returned to Kumara and held her rump in his mouth	
11.29	Chang crossed behind Kumara. She lay prone for a few seconds while he passed, then stood up (Fig. 4d)	
11.33		Chang kicked PoChin
11.52		Chang kicked PoChin
11.57		Chang hit PoChin with trunk
12.05	Chang hit Kumara with his head. Jangoli went to stand with her. Chang withdrew with Jangoli.	



Figs 3a-c: a. Chang (left) approaches Maya from the rear, b. Maya sits down when harassed by Chang, c. Upali (right) joins Chang in harassing Maya



Figs 4a-d: Sequence of photographs of Kumara appeasing Chang taken over a period of 14 min, a. Kumara (left) bowing to Chang (1115 hrs), b. Kumara (left) rubbing her head against Chang (1116 hrs), c. Kumara (right) bowing to Chang (1124 hrs), d. Kumara (left) lying prone briefly as Chang (middle) walks behind her from left to right (1129 hrs)

The two elephants first met in May 1989 when Kumara was moved to Chester, when Chang was 7.5 years old and Kumara was approximately 22 years old. Kumara regularly attacked Chang when he was young, but as he grew larger, he began to retaliate. At the time of this study, Kumara bore extensive scars on her back resulting from previous attacks by Chang (Jones, pers. comm.).

DISCUSSION

Previously unreported appeasement behaviours were displayed by adult female Asian Elephants in situations where they were being attacked or harassed by bulls, or following extended periods of separation from the adult bull. Similar behaviour appeared to be used by an adult cow to signal the absence of threat to a young, unrelated calf.

Lowering the head is an anti-threat appeasement behaviour in elephants (Manning 1972), since aggressive animals generally hold the head high. Lying down may also be categorised as an anti-threat behaviour. Crouching down and kneeling on the rear legs may be intended to appease an aggressor by arousing a conflicting, sexual tendency. In the few incidents of submission to mounting that were observed, this appeared to prevent further aggression, at least temporarily.

Appeasement behaviours in Asian elephants may serve the function of allowing subordinate animals to remain within a social group. It is interesting that the adult bull showed considerable aggression towards Kumara at the beginning of the study, but two and a half years later there was little sign of antagonism between them.

It is not surprising that the appeasement behaviours reported here exist in the Asian Elephant, as they are similar to behaviours displayed by many ungulate species. Neither is it surprising that appeasement behaviour of this type has not previously been reported from the wild. Studies of captive Rhesus Macaques (*Macaca mulatta*) have shown that submission and appeasement gestures increase in crowded conditions (de Waal 1996). Such behaviour is more likely to be observed in a captive environment, because animals that behave antagonistically towards each other cannot easily avoid contact.

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A MODEL FOR ESTIMATING BUTTERFLY SPECIES RICHNESS OF AREAS ACROSS THE INDIAN SUBCONTINENT: SPECIES PROPORTION OF FAMILY PAPILIONIDAE AS AN INDICATOR[1]

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The proportions of species in many of the five butterfly families (Hesperiidae, Papilionidae, Pieridae, Lycaenidae and Nymphalidae) found across the Indian subcontinent show a relatively invariant relationship with the overall butterfly species richness, at both local and regional scales. This relationship suggests that it is possible to use the species total of a single butterfly family best suited to estimate the overall species richness of all other butterflies in an area. Family Papilionidae is a logical choice over others for ease of sampling. Also, there is a strong positive correlation between Papilionidae species richness and the overall species richness of all other butterflies across all other areas, and the proportion of this family is reasonably invariant. The mean proportion (7%) of this family can thus be used to estimate the overall butterfly species richness of an area across the Indian subcontinent for which the Papilionidae species total is known.

Key words: Butterflies, Papilionidae, Indian subcontinent, species richness, spatial distribution

INTRODUCTION

The Indian subcontinent, which includes the area from Baluchistan (Pakistan) eastwards through India up to Myanmar and Sri Lanka, as well as the higher trans-Himalayan zone, is habitat for more than 1,439 species (Evans 1932, Haribal 1992) of butterflies representing 7.2-11.1% of the total world species [13,000 (Owen 1971) - 20,000 (Vane-Wright 1978)]. Amongst these, about 100 species are endemic to the Subcontinent (Smetacek 1996) and at least 26 taxa are today "globally threatened" (IUCN 1990). Identification and prioritisation of areas of conservation concern, i.e. butterfly biodiversity hotspots, are usually based on local endemic and relict taxa, their biogeographical affinities and globally threatened and rare status. However, prioritisation and selection of such areas requires estimation of various ecological indices [e.g. Shannon diversity index, Pielou's evenness index, Similarity index (Ludwig and Reynolds 1988)] which depend on the 'absolute species richness' of the species of the area. Data on the absolute butterfly species richness of most areas across the Subcontinent is non-existent. Traditional methods of deriving species richness by collecting and counting all the species in an area require much time, effort and resources, which were not easily available, and hence such studies have not been carried out in India. There is a need to evolve easy and cost effective methods to estimate the butterfly species richness of areas of concern.

Beccaloni and Gaston (1995) have proposed such a method to predict butterfly species richness of areas in the lesser known tropical forests of Central and South America, with the help of known species totals of only a single sub-family (Nymphalidae: Ithomiinae) also called the indicator group. This method is based on the fact that the proportions of species in many of the 14 subfamilies and families occurring in these forests show a relatively invariant relationship with the overall species richness of the area, on both local as well as regional scales. Besides, the species richness of this indicator group also has a strong positive correlation with the overall species richness of all the butterflies across the areas and the proportion (4.5%) of this group is reasonably invariant across tropical forests of central and south America. Keeping in mind the findings of Beccaloni and Gaston (1995), the present study was conducted to determine if proportions of butterfly species in families distributed over the Indian subcontinent are also invariant with respect to (i) species richness, (ii) spatial scale, (iii) forest type and (iv) butterfly subregional distribution in the Subcontinent. This study further tries to determine the potential indicator group amongst the 5 major families found in the subregion that can be used to estimate the species richness of other butterflies found in different areas in the Subcontinent.

METHODS

The Indian subregions

The Indian subcontinent (study area) forms a major part of the Oriental region, occupying its extreme northwestern limits. It has been divided into 9 butterfly subregions (Evans 1932, Wynter-Blyth 1957) as in Fig. 1. (i) Baluchistan or BA (northern limit up to Safed Koh: 26° 00'-34° 00' N and 62° 00'-70° 00' E) and (ii) Chitral or CL (72° 00' E and 36° 00' N) including Chitral, Hunza, Baltistan and Ladakh in both Pakistan and India (iii) western Himalayas or WH (Kashmir: 74° 00' E and 36° 00' N to Kumaon: 80° 00' E and 29° 00' N) in India, (iv) Central Himalayas or CH (Nepal: 80° 00'-88° 00' E to 30° 00'-27° 00' N), (v) Northeast India (includes eastern Himalayas from Sikkim: 88° 00' E and 29° 00' N to Arunachal Pradesh: 96° 00' E and 28° 00' N in India through Bhutan and parts of Bangladesh) and north Myanmar (up to Shan States: 97° 00'-100° 00' E to 28° 00'-20° 00' N) or NEI & NM, (vi) south Myanmar or SM (Karenni Hills: 97° 00' E and 19° 00' N to Victoria Point: 98° 00' E and 10° 00' N), (vii) Peninsular India or PI (Plains and hills of India south of the Himalayas, east of the Indus and west of Brahmaputra), (viii) Sri Lanka or SL, (ix) Andaman & Nicobar Islands or A&N of India. Butterfly species found in Baluchistan, Chitral and higher reaches (1,000-5,100 m) of the Himalaya (east, central and west) have strong Palaearctic affinities (Central Asian and Chinese subdivisions), whereas butterflies found in the Peninsular Indian, Malaysian and Indo-Chinese subdivisions have strong Oriental affinities. The drier low-lying areas of PI (Deccan and Indogangetic plains) also show affinity with the African region (Evans 1932, Wynter-Blyth 1957).

Methodology

Species totals of all the 5 commonly recognised butterfly families [Hesperiidae, Papilionidae, Pieridae, Lycaenidae and Nymphalidae (Ackery 1984)]. found in the Indian subcontinent were gathered. Literature spanning 117 years (1882-1999) across 69 areas of the Subcontinent was reviewed. However, in this paper, familywise species totals of only 56 areas, collected

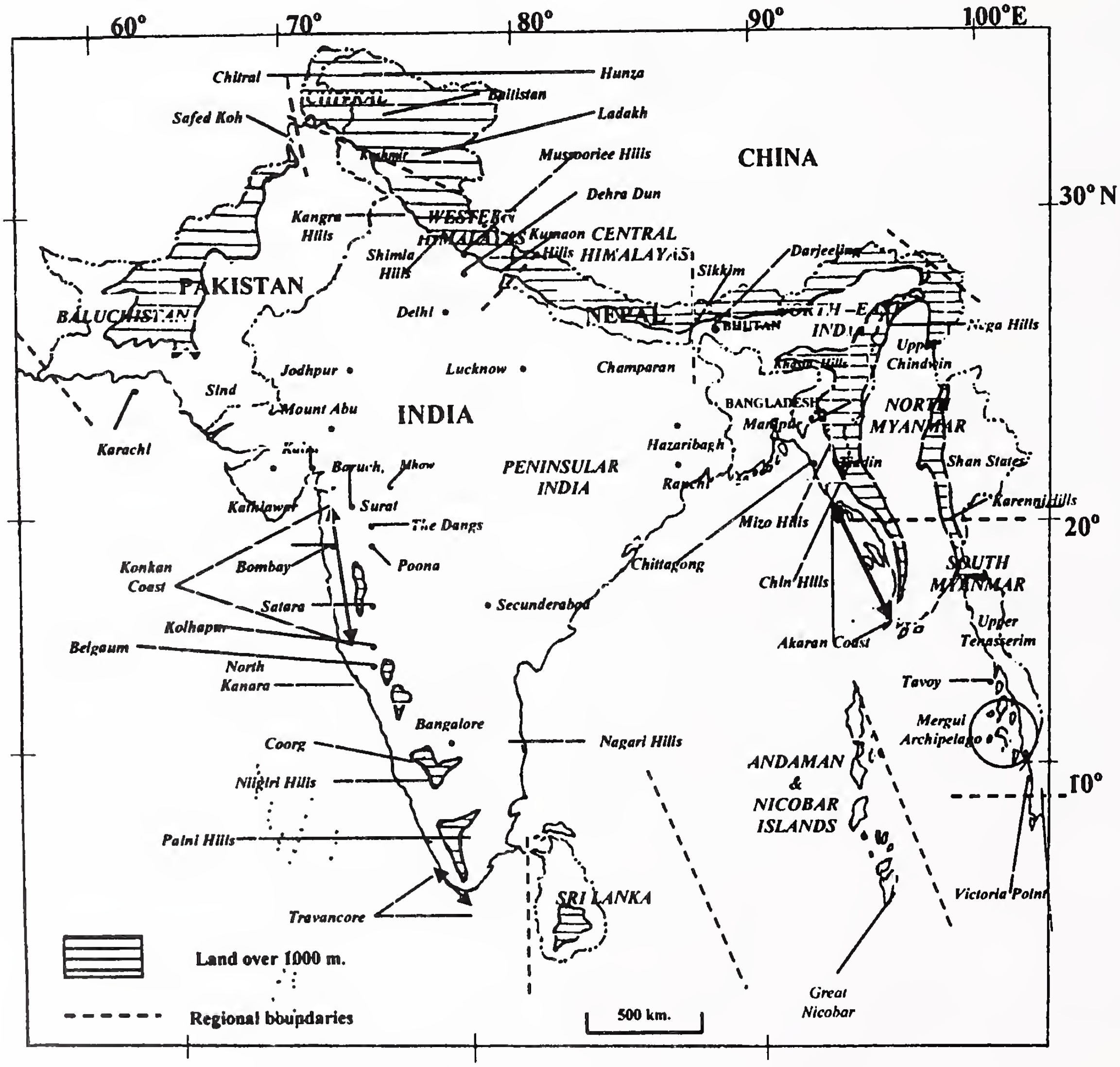
60°
70°
80°
90°
100°E
30° N
20°
10°
Chitral
Safed Koh
Baltistan
Hunza
Ladakh
CHITRAL
Kashmir
Mussooriee Hills
Dehra Dun
CHINA
Kangra Hills
WESTERN HIMALAYAS
Shimla Hills
Kumaon Hills
CENTRAL HIMALAYAS
PAKISTAN
BALUCHISTAN
Delhi
NEPAL
Sikkim
Darjeeling
BHUTAN
NORTH-EAST INDIA
Naga Hills
Upper Chindwin
Khasi Hills
Jodhpur
Lucknow
Champaran
Sind
Mount Abu
INDIA
BANGLADESH
Manipur
NORTH MYANMAR
Karachi
Kutch
Hazaribagh
Baruch.
Mhow
PENINSULAR INDIA
Ranchi
Shan States
Kathiawar
Surat
Mizo Hills
Karenni Hills
The Dangs
Konkan Coast
Bombay
Poona
Chittagong
Chin Hills
SOUTH MYANMAR
Satara
Secunderabad
Kolhapur
Upper Tenasserim
Belgaum
Akaran Coast
North Kanara
Tavoy
Bangalore
Mergui Archipelago
Coorg
Nagari Hills
ANDAMAN & NICOBAR ISLANDS
Nilgiri Hills
Palni Hills
SRI LANKA
Victoria Point
Travancore
Land over 1000 m.
Regional boundaries
500 km.
Great Nicobar

Fig. 1: Nine butterfly subregions of the Indian subcontinent and locations of collection sites

from 45 different sources of literature, have been used, as only these were based on comprehensive surveys for which (i) all the 5 butterfly families were sampled (ii) had a minimum collecting effort of ≥ 2 years (51 areas), (iii) showed no preference to a particular group for collection, (iv) covered all the 9 Indian butterfly subregions and (v) all the 14 major forest types (Champion and Seth 1968) found in the Subcontinent. The scientific names of butterflies used in the old records were updated and the species correctly placed in their respective families, based on the new nomenclature (Ackery 1984). The data was then analysed to derive the proportions of butterfly species in the 5 families from the 56 sites. The areas from which the data were used varied from smallest to the biggest site (sites < districts ≤ states ≤ sub-regions < the entire Subcontinent), and have been ranked on a spatial scale of 1-7, in an increasing order (Table 1). The details of the areas, their relative size, major vegetation types, collecting (sampling) effort and source of information are given in Table 1. Data on the number of butterfly species per family found in each of these areas is summarised in Table 2. [For one site "Khasia and Jaintia hills" in northeast India, the species totals of 4 families had been published by the authors, leaving out the total for Hesperiidae, although collections for all the 5 major families were done. Hence, the regional proportion of Hesperiidae (22.2%) for northeast India was taken as an approximate estimate for this site and added to the actual species total (464) of the other 4 families collected (which thus represented 77.8% of the total butterfly species found in this area) to derive the total species richness of this area i.e. 596 species. In this study, the smallest area in the Subcontinent was New Forest, Dehra Dun (4.40 sq. km), which lies in the Tropical Moist Deciduous forest zone of the western Himalaya.

However, the type of data used in this study is prone to error, including unequal sampling effort across areas. Under-recording of species is likely to affect the butterfly totals of the least rich areas more than those of the richest areas. At the site level, however, under-recording is likely to be greatest at the richest area.

RESULTS AND DISCUSSION

Patterns in Species Richness

The proportions of at least 3 out of the 5 families (Papilionidae, Lycaenidae and Nymphalidae) are more or less independent of the total species richness, or size of the area, or forest type, or butterfly subregion, in the Indian subcontinent (Table 2; Figs. 2, 3). The comparatively invariant relationship exhibited by these families is simpler than the relationships shown by families Hesperiidae and Pieridae. The proportion of Hesperiidae increases with the total species richness, whereas that of Pieridae decreases (Fig. 2). This variation for these two families is more pronounced across the continuous mountainous subregions [Baluchistan-Chitral-Himalayas (western-central-eastern)-Hills of Myanmar (north-south)] (Fig 1). The proportion of Hesperiidae, in general, increases from Baluchistan towards south Myanmar [BA(11.8) - CL (8.4) - WH (15.1) – CH (20.1) - NEI & NM (21.9) - SM (24.0)], whereas that of Pieridae decreases across the same region [BA (21.8) CL (18.1) - WH (10.1) - CH (9.9) - NEI & NM (5.9) - SM (5.1); Table 2].

As proportions of the first 3 families are invariant and show a simple relation to the total species richness, it is possible to use the known species totals of the most suitable of these three groups in an area to estimate the total butterfly species richness of that area. Also, none of these 3 groups show 'saturation' (Beccaloni and Gaston 1995), as their proportions do not decrease with the increase in total species richness. Therefore, all three are potential indicator groups.

Selecting an indicator group

For a group to be an indicator, there should be low variance in the relationship between the species richness of this group and that of the group we wish to predict (Beccaloni and Gaston 1995). Amongst the 3 families identified as potential indicators, Papilionidae ($\overline{x} = 7.0301$; SD = 1.1879; n = 51; CV = 16.90) and Lycaenidae ($\overline{x} = 29.0151$; SD = 3.6779; n = 51; CV = 12.68) have low variance values ($s^2 < \overline{x}$) for proportion (arcsin transformed) of species in families across the Subcontinent, as compared to Nymphalidae ($\overline{x} = 33.4740$; SD = 05.9583; n = 51; CV = 17.80) which exhibits a comparatively large variance ($s^2 \geq \overline{x}$) across the same region. Thus, families Lycaenidae and Papilionidae are more suitable potential indicator groups than Nymphalidae for predicting species richness across the Subcontinent.

Why choose Papilionidae over Lycaenidae as indicators?

Papilionidae (commonly called Swallowtails) are taxonomically and ecologically well known in the Indian subcontinent, and the distribution of practically all the species is known. In contrast, many of the species in Family Lycaenidae are very difficult to identify and very little is known about their life history and ecology because of their obscure habits. Swallowtails (as the name suggests, most of them have tails on their hind wings) are (i) large in size (wing span: 5 - 19 cm for

Table 1: Details of the areas taken in this study and sources from which the butterfly totals in Table II were obtained

Sl. No.	Areas	Area covered (spatial scale: 1-7)*	Major Vegetation Types ** (01-14)	Collecting effort	Sources
1.	**Indian subcontinent (61°- 100° E, 5° - 37° N)**	**7**	**01-14**	**Over 100 years (Cumulative)**	**Evans (1932); Haribal (1992)**
2.	**Baluchistan**	**6**	**10**	**Over 100 years (Cumulative)**	**Evans (1932); Wynter-Blyth (1957)**
3.	**Chitral** (Chitral, Hunza, Baltistan and Ladakh)	**6**	**10, 13, 14**	**Over 100 years (Cumulative)**	**Evans (1932); Wynter-Blyth (1957)**
4.	Chitral	5	10, 13	Feb. 1900-Nov. 1901	Leslie and Evans (1904)
5.	**Western Himalaya** (Kashmir-Kumaon)	6	03, 09, 12, 13, 14	Over 100 years (Cumulative)	Evans (1932); Wynter-Blyth (1957)
6.	Kangra Hills district	4	05, 09, 10, 12	Several years	Moore (1882)
7.	Shimla Hills (Kinnaur, Kullu, Shimla, Solan, Kalka districts and Chandigarh)	5	06, 09, 12, 13, 14	>19 years (Cumulative)	Wynter-Blyth (1940; 1945)
8.	Dehra Dun Valley (New Forest Campus)	1	03	6 years (1988-92; 1997-98)	Singh (1999)
9.	Mussoorie Hills and neighbouring areas (Uttarkashi, Tehri Garhwal, Dehradun districts)	5	03, 09, 12, 13, 14	11 years (1887-1898)	Mackinnon and deNiceville (1899)
10.	Mussoorie Town	2	12	Several years (consecutive)	Ollenbach (1930)
11.	Kumaon Hills (Almora, Nainital and Pauri Garhwal districts)	5	03, 09, 12, 13, 14	>2 years (1908-1909 and before)	Hannyngton (1910)
12.	**Central Himalaya** (Nepal)	**6**	**03, 09, 12, 13, 14**	**Over 100 years (Cumulative)**	**Haribal (1992)**
13.	**North-East India + North Myanmar**	**6**	**01, 02, 03, 08, 09, 11, 14**	**Over 100 years (Cumulative)**	**Evans (1932)**
14.	Northeast India (Sikkim, Bhutan, Assam-Chittagong)	6	01, 02, 03, 08, 09, 11, 14	Over 100 years (Cumulative)	Wynter-Blyth (1957)
15.	Sikkim	4	09, 11, 12, 13, 14	>40 years (cumulative, mainly from 1880-1920 thereafter)	Haribal (1992)
16.	Darjeeling district	4	02, 03, 08, 11, 12, 14	Several years (consecutive) (1889-1890 and thereafter)	Maude (1949)
17.	Naga Hills (Nagaland)	4	01, 08, 09, 11		Tytler (1911-12)
18.	Manipur and Naga Hills	5	01, 08, 09, 11	3 years (consecutive)	Tytler (1914)
19.	Khasia Hills (Meghalaya)	5	01, 03, 08, 09, 11	3 years	Swinhoe (1893)
20.	Khasia and Jaintia Hills	5	01, 03, 08, 09, 11	>2 years (before and 1948-1949)	Parsons and Cantlie (1951)
21.	Chin- Lushai (Mizoram) Hills	4	02, 03, 08, 09	Oct. 1889 - May 1890	Watson (1891)
22.	N. Chin and Upper Chindwin district	4	02, 03, 08, 09, 11	(Jan-June, 1893)	Watson (1897)
23.	Arakan Coast	4	01, 08	Nov. 1944 - June 1945	Gladman (1949)
24.	Shan States	5	01, 02, 03	1887-1888	Neville Manders (1890)
25.	**South Myanmar**	**5**	**01, 04, 08**	**Over 100 years (Cumulative)**	**Evans (1932)**
26.	Upper Tenasserim (Rangoon, Paungde and Bilin)	5	02, 03, 08	Sept. 1885 - Dec. 1886	Watson (1886)

Table 1: Details of the areas taken in this study and sources from which the butterfly totals in Table II were obtained (*contd.*)

Sl. No.	Areas	Area covered (spatial scale: 1-7)*	Major Vegetation Types ** (01-14)	Collecting effort	Sources
27.	Tavoy District	5	01, 02, 04	10 years (1910-1920)	Ollenbach (1920)
28.	Mergui and its Archipelago	4	01, 02, 04	Expedition?	Moore (1886)
29.	Myanmar	6	01, 02, 03, 04, 05, 06, 08, 09	Over 100 years (Cumulative)	Haribal (1992)
30.	**Peninsular India** (West, Central and South of Subcontinent)	**7**	**01, 02, 03, 04, 05, 06,** 07, 08, 11	**Over 100 years (Cumulative)**	**Evans (1932); Wynter-Blyth (1957)**
31.	Central Provinces (mainly Madhya Pradesh and drier parts of Orissa and Maharashtra)	6	03, 05	Several years (consecutive)	Betham (1890-92)
32.	Calcutta	2	02	Several years (consecutive)	Sanders (1944) and Sevastopulo (1944)
33.	South Bihar (Patna, Ranchi, Hazaribagh and Manbhum districts)	4	03, 05	Several years (consecutive)	Morrison-Godfrey (1950)
34.	North Bihar (Champaran district)	4	03	Several years (Sept. - May; before 1950)	Harman (1952)
35.	Lucknow	4	05	4 years (consecutive)	DeRhe-Philipe (1902)
36.	Delhi	4	06	4 years (1961-65)	Donahue (1966 -1967)
37.	Mhow	2	05	1 year (1881-1882)	Swinhoe (1886)
38.	Jodhpur and Mount Abu	3	05, 06, 08	3 years (1920,1924-25)	Macpherson (1927)
39.	Karachi	3	06	2 years (1878-1880)	Swinhoe (1884)
40.	Sind Province	6	06	15 years (1932-1947)	Menesse (1952)
41.	Central Gujarat (Kathiawar)	5	05, 06	2 years (Dec. 1927 - March 1929)	Mosse (1929)
42.	North Gujarat (Keda/Kaira district)	4	06	3 years (1941-44)	Aldrich (1949)
43.	South Gujarat (Bharuch, Surat and Dangs districts)	5	03, 06	17 years (1946-1963)	Shull (1963)
44.	Bombay-Deccan (mainly Poona and forested parts of Satara, Kolhapur, Belgaum and Ahmednagar districts)	4	01, 02, 03, 05, 06, 08	>2 years (1982-3; 1877)	Swinhoe (1885)
45.	Konkan Coast	5	02, 03, 08	Several years (1885-1902, cumulative)	Aitken and Comber (1903)
46.	North Kanara district (Uttar Kannada)	5	01, 02, 03	>2 years (1891-1892)	Davidson *et al.* (1896-1897)
47.	Coorg (Kodagu) district	4	01, 02	>11 years (before 1927, 1927-1929)	Yates (1931-32)
48.	Bangalore district	5	05	3 years (1925-1927)	Yates (1933)
49.	Travancore (Kerala and South Tamil Nadu)	5	01, 02, 03	13 years (1878-1891)	Ferguson (1891)
50.	Palni Hills	3	03, 08, 11	10 years (1950-1960)	Ugarte and Rodericks (1960)

Table 1: Details of the areas taken in this study and sources from which the butterfly totals in Table II were obtained (*contd.*)

Sl. No.	Areas	Area covered (spatial scale: 1-7)*	Major Vegetation Types ** (01-14)	Collecting effort	Sources
51.	Nilgiri Hills	4	03, 08, 11	Several years (cumulative, based on Hampson, 1888 list)	Wynter-Blyth (1944; 1947)
52.	Nagalapuram Hills (Eastern Ghats: Nagari-Kalahasti)	4	07	1.5 years (August 1950 - Feb. 1952)	Best (1958)
53.	Secunderabad	3	06	1 year (1933-34)	Logan Home (1935)
54.	**Sri Lanka**	**5**	**01, 02, 08, 11**	**Over 100 years (Cumulative)**	**Haribal (1992)**
55.	**Andaman and Nicobar Islands**	**4**	**01, 02, 03, 04**	**Over 100 years (Cumulative)**	**Evans (1932); Wynter-Blyth (1957)**
56.	Great Nicobar Island	4	01,02,03,04	Several years (1979-1993 cumulative)	Chandra and Khatri (1995)

*Spatial Scale (sq. km): 1 = <10; 2 = >10-100; 3 = >100-1,000; 4 = >1,000-10,000; 5 = >10,000-1,00,000; 6 = >1,00,000-10,00,000; 7 = >10,00,000

** Vegetation (Forest) Types (Champion and Seth, 1968): 01-Tropical Wet Evergreen; 02 - Tropical Semi Evergreen; 03 - Tropical Moist Deciduous; 04 - Littoral and Swamp; 05 - Tropical Dry Deciduous; 06 - Tropical Thorn Forest; 07 - Tropical Dry Evergreen; 08 - Sub-tropical Broad-leaved Hill; 09- Sub-tropical Pine; 10 - Sub-tropical Dry Evergreen; 11- Montane Wet Temperate; 12 - Himalayan Moist Temperate; 13 - Himalayan Dry Temperate; 14 - Sub-Alpine or Alpine

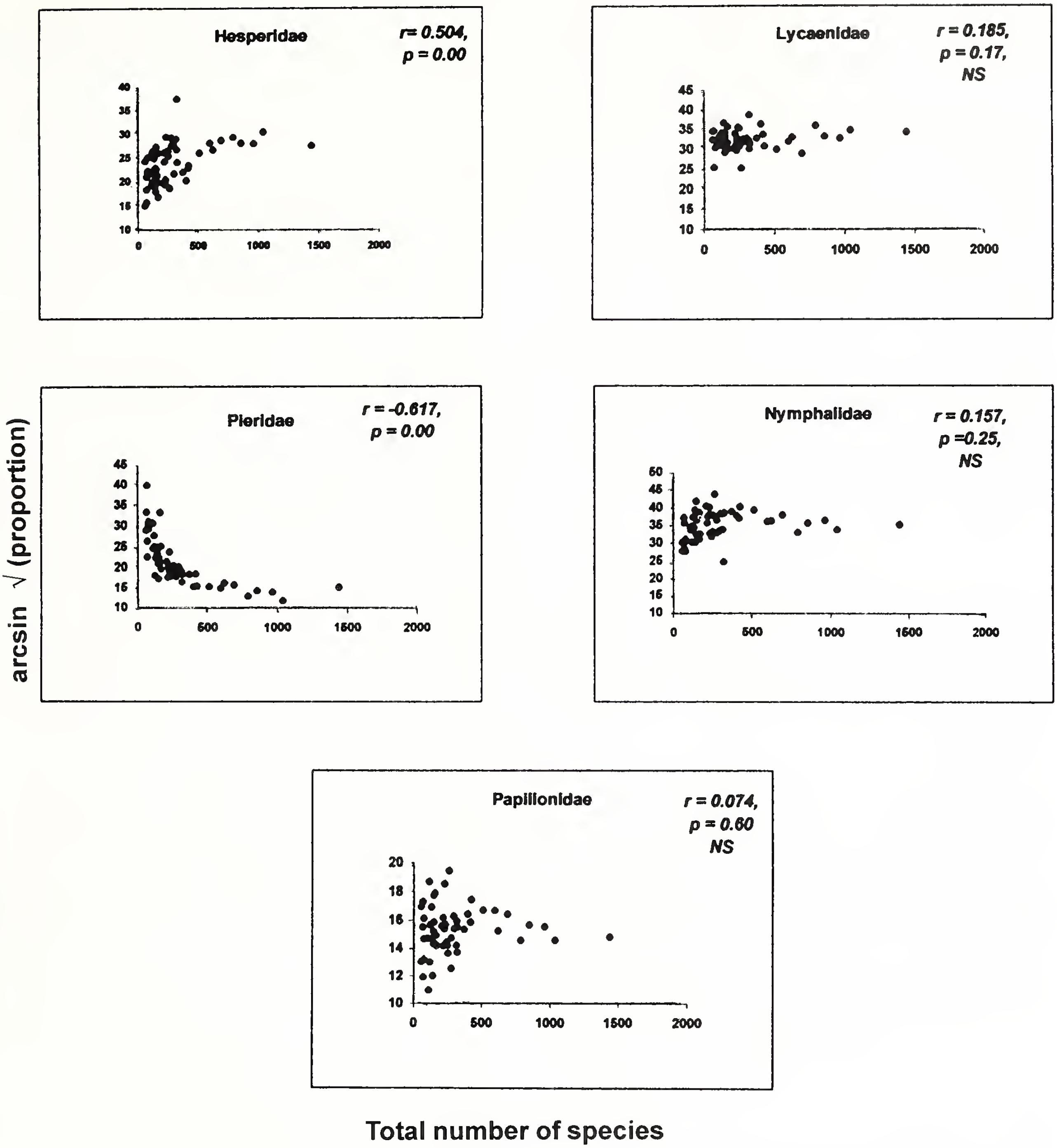

Fig. 2: Relationship between the proportions of species in a given butterfly family (arcsine transformed) and overall butterfly species richness of collection sites (n=56) across the Indian subcontinent

Indian species) (ii) very active and strong fliers during daylight, when they can be observed flying, or feeding on flower nectar, or mud puddling, but seldom concealing themselves in foliage or settling down to rest, and are also (iii) eyecatching and colourful, with contrasting black as their base colour. In contrast, most of the Lycaenidae are (i) very small or medium sized (wing span: 1.5 - 6 cm. for Indian species) (ii) cannot be easily identified in flight or even at rest, as allied species of the same genus have similar patterns on the underside of the wings and (iii) are not active fliers like Papilionidae, as they are unable to fly for long stretches and soon settle down to rest (Haribal 1992, Wynter-Blyth 1957). Also, Papilionidae with 94 species (7.01%) is also a smaller group to monitor than Lycaenidae with 459 species (29.22%) (Table 2). All these unique characters of Papilionidae make it an easier group to observe, identify and sample than Lycaenidae.

Besides, the average life span of adult Indian Papilionids ranges from 20-30 days to a maximum of

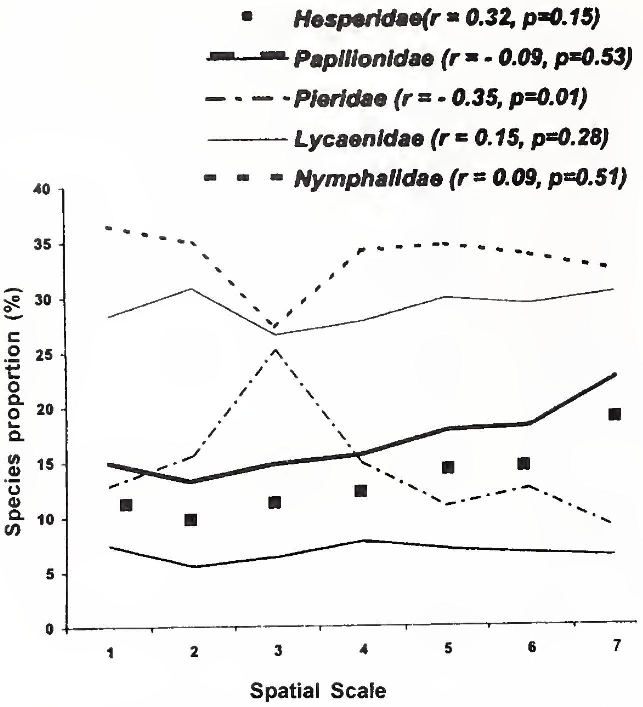

Fig. 3: Relationship between the proportion (%) of species in different families of butterflies and the spatial distribution of collection sites (n=56). Geographical scale (sq. km) 1. <10, 2. >10 to 100, 3. >100 to 1000, 4. >1000 to 10,000, 5. >10,000 to 1,00,000, 6. >1,00,000 to 10,00,000, 7. >10,00,000

4 months (Haribal 1992). Their flight period in the plains ranges from January to December with many overlapping generations, whereas in the hills they fly during summer, between April to September, and have 1-3 generations (Wynter-Blyth 1957), thus Papilionidae can be sampled for a longer period in the year. Papilionidae are found in all types of habitats (gardens, forests, open areas, etc.) from the low lying Indian plains to as high as 5,100 m above msl in the Himalaya (Common Blue Apollo *Parnassius hardwickei* Gray) (Wynter-Blyth 1957). A large proportion (14.5%) of the worldwide total of 650 Papilionid species is known to occur in the Indian subcontinent (Haribal 1992). Papilionid species richness in the Indian subcontinent peaks in NEI & NM where a large concentration is found [Sikkim (55 species in 7,299 sq. km: Haribal 1992); North-east India (62 species in 3,68,000 sq. km) and Myanmar (66 species in 6,76,577 sq. km): Wynter-Blyth 1957].

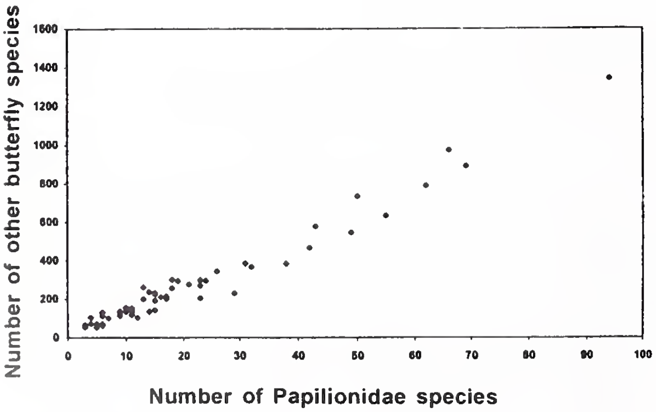

Fig. 4: Plot of butterfly species richness (excluding Papilionidae) versus Papilionidae species richness for sites (n=56) across the Indian subcontinent

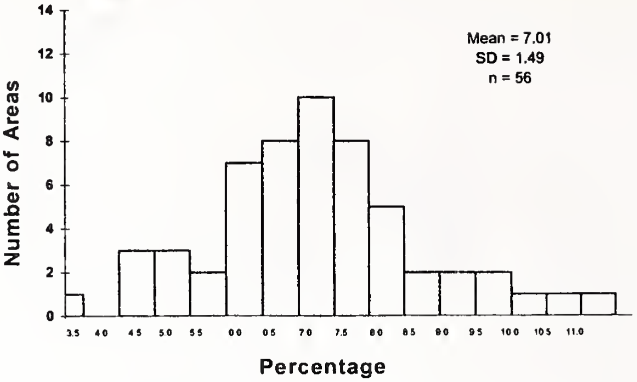

Fig. 5: Distribution of the Papilionidae proportions of different collection sites (n=56) across the Indian subcontinent

Are Papilionidae good indicators for predicting species richness?

A strong positive relationship exists between Papilionidae species richness and the overall species richness (of all the other butterfly families) across 56 different areas over the entire Indian subcontinent, and varying on different spatial scales [(1-7; Table 1) and ($r = 0.980$, $n = 56$, $p < 0.01$; Fig. 4). The histogram

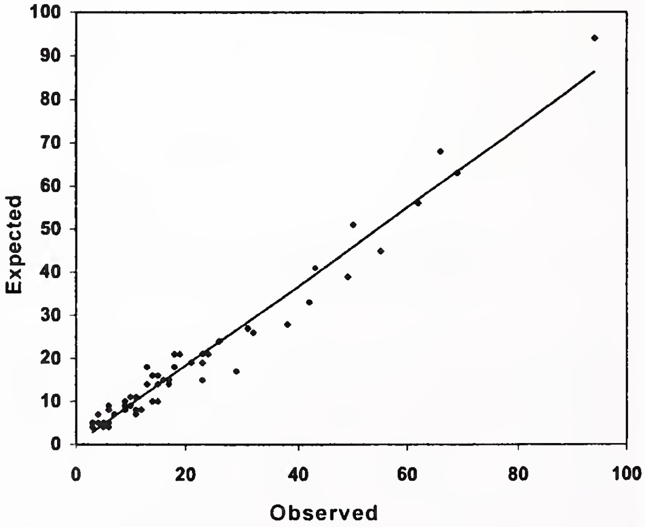

Fig. 6: Relationship between the number of Papilionidae observed and expected to occur in different sites across the Subcontinent (expected values based on the assumption that Papilionidae constitute an invariant proportion of the total butterfly species found across the entire Subcontinent)

Table 2: Total butterfly species richness of areas in the Indian subcontinent and the proportion of species recorded in the families

Sl.no.	Area	Total Species	Percentage of total				
			Hesperiidae	Papilionidae	Pieridae	Lycaenidae	Nymphalidae
1.	**Indian subcontinent**	**1439**	**21.3 (307)**	**06.5 (94)**	**06.9 (99)**	**31.8 (459)**	**33.3 (480)**
2.	**Baluchistan**	**119**	**11.8 (14)**	**05.0 (6)**	**21.8 (26)**	**28.6 (34)**	**32.8 (39)**
3.	**Chitral**	**166**	**08.4 (14)**	**06.6 (11)**	**18.1 (30)**	**27.7 (46)**	**39.2 (65)**
4.	Chitral	139	10.8	04.3	15.8	28.8	40.3
5.	**Western Himalaya**	**417**	**15.1 (63)**	**07.4 (31)**	**10.1 (42)**	**30.9 (129)**	**36.5 (152)**
6.	Kangra Hills	228	11.0	10.1	16.2	24.6	38.2
7.	Shimla Hills	299	13.7	07.0	11.4	29.4	38.5
8.	Dehra Dun Valley (New Forest)	148	14.9	07.4	12.8	28.4	36.5
9.	Mussoorie Hills and adjoining areas	323	16.7	07.1	09.9	27.3	39.0
10.	Mussoorrie Town	146	09.6	06.8	08.9	30.1	44.5
11.	Kumaon Hills	371	14.0	07.0	10.0	29.4	39.6
12.	**Central Himalayas (Nepal)**	**623**	**20.1 (125)**	**06.9 (43)**	**07.9 (49)**	**29.7 (186)**	**35.3 (220)**
13.	**North-East India + North Myanmar**	**962**	**21.9 (211)**	**07.2 (69)**	**05.9 (57)**	**29.5 (283)**	**35.5 (342)**
14.	Northeast India	853	22.2	07.3	06.1	30.2	34.2
15.	Sikkim	690	23.0	08.0	07.4	23.5	38.1
16.	Darjeeling district	262	10.3	11.1	12.2	18.3	48.1
17.	Naga Hills	423	15.9	09.0	07.1	26.0	41.8
18.	Manipur and Naga Hills	321	37.1	05.6	00.3	39.2	17.8
19.	Khasia Hills	510	19.2	08.2	07.0	25.0	40.5
20.	Khasia and Jaintia Hills	596	22.2	08.2	06.7	27.8	34.7
21.	Chin- Lushai (Mizoram) Hills	276	21.4	04.7	09.4	27.9	35.5
22.	N. Chin and Upper Chindwin district	320	20.3	07.5	08.1	25.3	38.8
23.	Arakan Coast	159	13.2	09.4	13.2	26.4	37.7
24.	Shan States	228	12.3	07.0	11.0	28.1	41.7
25.	**South Myanmar**	**788**	**24.0 (189)**	**06.3 (50)**	**05.1 (40)**	**34.5 (272)**	**30.1 (237)**
26.	Upper Tenassrium	252	19.8	05.6	10.7	26.2	37.7
27.	Tavoy district	401	12.0	08.0	07.0	35.1	37.9
28.	Mergui and its Archipelago	208	11.5	07.2	13.5	25.5	42.3
29.	Myanmar	1039	25.6	06.3	04.2	32.5	31.3
30.	**Peninsular India**	**315**	**23.5 (74)**	**06.0 (19)**	**10.8 (34)**	**28.6 (90)**	**31.1 (98)**
31.	Central Provinces	147	21.1	06.1	13.6	23.8	35.4
32.	Calcutta	167	19.2	06.0	11.4	34.1	29.3
33.	South Bihar	124	14.5	07.3	09.7	37.1	31.5
34.	North Bihar	151	12.9	06.8	15.0	25.2	40.1
35.	Lucknow	109	13.8	06.4	17.4	30.3	32.1
36.	Delhi	77	14.3	05.2	26.0	28.6	26.0
37.	Mhow	110	10.9	03.6	26.4	28.2	30.9
38.	Jodhpur and Mount Abu	78	17.9	07.7	26.9	25.6	21.8
39.	Karachi	70	12.9	04.3	41.4	18.6	22.9
40.	Sind Province	59	16.9	05.1	23.7	32.2	22.1
41.	Central Gujarat (Kathiawar)	78	14.1	06.4	24.4	28.2	26.9
42.	North Gujarat (Kaira)	59	06.8	08.5	30.5	28.8	25.4
43.	South Gujarat	145	15.2	06.9	17.2	31.7	29.0
44.	Bombay-Deccan (Pune)	164	11.6	06.1	30.5	25.0	26.8
45.	Konkan Coast	130	17.7	08.5	14.6	26.9	32.3
46.	N. Kanara district	233	24.0	07.3	09.4	29.6	29.6
47.	Coorg	278	21.6	06.5	11.2	28.8	29.9
48.	Bangalore district	140	14.0	06.4	17.9	35.7	25.7
49.	Travancore	220	16.8	06.8	11.8	26.4	37.3
50.	Palni Hills	249	18.5	06.0	12.0	33.3	30.1
51.	Nilgiri Hills	294	21.8	07.8	11.9	27.9	30.6
52.	Nagalapuram Hills (Eastern Ghats)	117	19.7	10.3	17.9	26.5	25.6
53.	Secunderabad	70	10.0	07.1	20.0	28.6	34.3
54.	**Sri Lanka**	**242**	**19.8 (48)**	**06.2 (15)**	**12.0 (29)**	**33.9 (82)**	**28.1 (68)**
55.	**Andaman and Nicobar Islands**	**217**	**19.4 (42)**	**06.0 (13)**	**09.2 (20)**	**31.3 (68)**	**34.1 (74)**
56.	Great Nicobar Island	68	07.3	08.8	14.7	32.4	36.8

Values in parenthesis are species totals for nine butterfly sub-regions and the whole of the Indian subcontinent so far known

(Fig. 5) demonstrates that the variance of Papilionidae proportions across these areas is reasonably low, with Papilionidae constituting 6-8% of the butterfly species in 28 out of 56 areas (and 6.5-7.5% in 18 out of 56 areas) in the Subcontinent.

Five areas [Mhow, Chitral, Chin-Lushai (Mizo) Hills, Darjeeling Hills and Nagalapuram (Nagari) Hills; Table 2] could have been excluded from this analysis, thereby increasing the level of correlation. The first three have the lowest proportions of Papilionidae (Mhow 3.6%, Chitral 4.3% and Chin Lushai 4.7%) of all areas. Data of Mhow and Chin-Lushai suffer from sampling error as less than one year of collecting effort was undertaken. However, data from Chitral also includes a large number of Palaearctic species besides the Oriental species (as this region has strong affinities with the Palaearctic region), which are likely to decrease the proportion of Oriental species. The last two areas, on the other hand, have the highest proportions of Papilionidae of all areas [Nagalapuram Hills (10.3%) and Darjeeling (11.1%)]. Data from Nagalapuram Hills (with only 1.5 years of sampling) is also under-sampled, particularly for Nymphalidae (Table 2). On the other hand, the exact sampling period for Darjeeling district is not mentioned in the original text (Maude 1949) but the data reflects low sampling of species from this area, particularly those of the families Hesperiidae and Lycaenidae (Table 1).

A combined data set for sites, districts, states and regions was tested against random draw model in which the proportion of Papilionidae in each area was assumed to equal that for the whole of the Subcontinent (6.5%). Correlation between the number of Papilionid species observed and expected to occur in each area is high ($r = 0.982$; $n = 55$, $p = 0.001$) and the relationships are fitted by a slope of 1 (Fig. 6).

CONCLUSION

A reasonably invariant relationship exists between proportions of Papilionid species and the overall butterfly species richness across the Indian subcontinent, independent of (i) the different butterfly sub-regions (ii) forest types found in the region (iii) different spatial scales and (iv) species richness of areas. This suggests that it should be possible to use the average proportion (7%) of this family to estimate the butterfly species richness of areas across the Indian subcontinent, for which the Papilionidae species total is known. Using the figure for the overall butterfly richness of an area, approximate estimates for the species totals of the individual butterfly groups in the area can be generated on the basis of known relationships between total butterfly species richness and the species richness of the groups across all areas (provided that these are strong). In the Indian subcontinent, the species richness of at least three families, Papilionidae, Lycaenidae and Nymphalidae, show little variation, and their regional proportions can be used to estimate the species totals. However, for families such as Hesperiidae and Pieridae, that show a larger variance across the 9 butterfly sub-regions in the Indian subcontinent, sub-regional proportions are already known (Table 2) and would give more precise estimates of this relationship for predicting the species richness of the respective families.

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NEST-SITE CHARACTERISTICS OF BLACK-NECKED STORK (*EPHIPPIORHYNCHUS ASIATICUS*) AND WHITE-NECKED STORK (*CICONIA EPISCOPUS*) IN KEOLADEO NATIONAL PARK, BHARATPUR, INDIA[1]

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Studies conducted in the Keoladeo National Park during 1994-1997 on nest-site selection in the Black-necked Stork (*Ephippiorhynchus asiaticus*) and White-necked Stork (*Ciconia episcopus*) showed that girth at breast height (GBH), height and canopy spread were the major factors governing the placement of nests. There were significant differences between the height, canopy spread, and GBH of nesting and non-nesting trees used by the two stork species. The Black-necked Stork nested on top canopies of tall Babool *Acacia nilotica* trees with high GBH, while the White-necked Stork nested on *Mitragyna parvifolia*, in the dense middle foliage.

Key words: black-necked stork, *Ephippiorhynchus asiaticus*, white-necked stork, *Ciconia episcopus*, nest-site, Keoladeo National Park, India

INTRODUCTION

Selection of a safe nesting site is among the prime concerns of all birds because nest location is a major factor that governs the successful rearing of chicks. The selected site should provide protection against predation of eggs and nestlings. If the chicks were altricial an appropriate site would provide protection against difficult environmental conditions (Walsberg and King 1978), avian predators and structurally support the nest (Burger 1974). Selection of a nesting tree, height of the nest, location of the nest on the tree, and social and vegetation factors influence nesting (Beaver *et al.* 1980; Burger and Gochfeld 1981; Parsons 1982; Clark *et al.* 1983; Donazar *et al.* 1993; Thompson and Slack 1982). This study on the Black-necked and White-necked Storks was conducted during a study of their breeding and feeding ecology in Keoladeo National Park at Bharatpur, India.

The White-necked Stork *Ciconia episcopus* forages in shallow wetlands up to 20 cm deep to flooded grassland (Ishtiaq 1998). It feeds on small fishes, earthworms and amphibians. These shallow feeding sites are ephemeral in nature and the White-necked Stork uses sites outside as well as inside the Keoladeo National Park. The Black-necked Stork *Ephippiorhynchus asiaticus* feeds in deep water up to 35 cm. It is a generalist, feeding on a wide variety of large items, including fishes, Common Coot *Fulica atra*, Northern Shoveller *Anas clypeata*, Pheasant-tailed Jacana *Hydrophasianus chirurgus* and snakes (Ishtiaq 1998). It feeds inside and outside the Park.

In northern India, the nesting season of the White-necked Stork begins before the onset of monsoon, which varies, but usually begins in June and lasts through September. Black-necked Stork starts breeding by the end of September up to January (after the monsoon). Like other wading birds, the breeding success of the Black-necked Stork depends on the amount of rainfall and time of water released inside the Keoladeo National Park. Monsoon acts as a trigger for breeding and water brings about 19 million fingerlings (Vijayan 1991), which are well grown by the time the Black-necked Stork starts nesting. The rejuvenation of the insect and earthworm supply due to the monsoon provides food for the White-necked Stork.

The status of the White-necked Stork in the Park was neglected in the past, and no nest counts had been conducted within the Park. The population of the Black-necked Stork, in contrast, has been well studied, and is stable at about six pairs (Rahmani 1989). The present study was the first investigation of nest-site selection in both the stork species in Keoladeo National Park.

STUDY AREA

The Keoladeo National Park is located at Bharatpur, Rajasthan (27° 7.6' to 27° 12.2' N, 77° 33.9' E) (Vijayan 1991), and has an area of

29 sq. km. Eight sq. km of the wetland is divided into 15 (A-O) compartments (blocks) by earthen dykes and the remaining constitute terrestrial habitats. The boundary of the Park is demarcated by a masonry wall and is surrounded by 18 villages. Although grazing of domestic cattle and buffalo has been banned, the villagers are still allowed to collect fodder from the Park during April-June.

The climate of Bharatpur is tropical, sub-humid to semiarid, and it experiences climatic extremes from a hot, dry summer (April-June) to a cool winter (November-January) and short monsoon (July-September) and post-monsoon (September-October) seasons. The flora of Bharatpur has been intensively studied (Prasad *et al.* 1996), and is a mixture of xerophytic and semi-xerophytic species including *Acacia nilotica*, *Prosopis cineraria* and *Salvadora oleoides*.

Keoladeo National Park is located at the confluence of two rivers, the Banganga and Gambhir, which bring water to the Ajanbund reservoir. Water is brought to the Park through the Ghana canal in July and August, and the bund is emptied in October. The flow of water in the Park is regulated by sluice gates. Vijayan (1991) has studied the ecology of this monsoonal wetland in detail for ten years.

METHODS

During the study period from 1994-1997, nests of the Black-necked and White-necked Storks were identified by following adults collecting nesting material, to the nesting tree. Each nesting tree was sampled for vegetation structure to analyse selection strategies. Sampling of nest trees was done using belt transects 6 m (3 m on both sides) wide and 30 m long in four directions from the nesting tree. All the trees within this transect were identified up to species level. Measurements were taken from each nest tree for girth at breast height (GBH) >30 cm, height >2 m, tree species and canopy spread. Sampling of nesting trees was done after the breeding season to minimize disturbance.

Nest material and nest dimensions were also recorded. The variables measured were as follows:

1. Nesting tree species: structure of the tree and its ability to support the nest.
2. Tree height: the height of the tree was estimated visually.
3. Girth at breast height (GBH): The diameter of the tree at the height of 1.5 m.
4. Canopy spread: the length and breadth of the canopy of the nesting tree was measured.
5. Water depth: depth of water around the nesting tree that protects the nest from predators. The water depth was recorded at least three times during the nesting season.
6. Distance to feeding area: the nearest block unoccupied by a conspecific nest and holding water.
7. Distance to Park boundary: the shortest distance to the Park boundary from the nesting tree; this allows a measure of the number of trips made by the adults as they go for feeding after the sudden rise in water level soon after the water is released, as well as proximity to human activity.
8. Distance to water source outside the Park: the presence of wetlands outside the Park boundary as a measure of proximity to foraging areas.
9. Distance to road: the road nearest to the nesting tree, to know the distance from human disturbance, especially grass-cutters.
10. Distance to nest: the distance to the nest of other nesting species that could be potential predators, such as raptors, large owls.

Analyses

We used a multi-variate ordination technique, Principal Component Analysis (PCA). PCA was performed on the nesting data to determine the important factor(s) responsible for nest site selection in Black-necked and White-necked Storks. All analyses were performed on STATA 5.0 (STATA Corp. 1997) and SPSS 6.1 (Norussis 1994). We did a logistic regression on the nest-site selection variables and t-tests on differences between nesting and non-nesting trees of White-necked and Black-necked Storks.

RESULTS

Nest characteristics of the White-necked Stork

A total of 15 nests of White-necked Storks were counted during 1994-1997. However, not much information was gathered during 1994 as breeding was over by the time we started the study. Nests were found on two tree species. The White-necked Storks used *Mitragyna parvifolia* (12 nests) inside the Park, and *Dalbergia sissoo* when outside the Park (3 nests). The mean height of the nests from the ground was (mean ±s.d.) 4.5 ±1.3 m (n=6). All the nests were located in the dense middle strata of the tree. The mean depth of four nests was 14.74 ±10.50 cm, mean length was 93.45 ±41.19 cm and mean breadth was 67.97 ±39.93 cm (mean ±s.d.).

Both sexes take part in nest construction and incubation. In the White-necked Stork, both male and female brought nesting material, including green leaves of *Mitragyna parvifolia*, *Prosopis juliflora*, *Capparis decidua*, *Panicum paludosum*, *Paspalum distichum*, *Kirgnelia reticulata*, *Syzigium cumini* and dry blades of Khus grass (*Vetiveria zizanioides*).

Nest characteristics of the Black-necked Stork

During the study period, six pairs of Black-necked Stork were seen inside the Park. The nesting trees of the Black-necked Stork for most of the pairs in Keoladeo National Park remained unchanged during the study period (Ishtiaq 1998). A total of 12 nests were constructed during 1994-1996; all the nesting trees were surrounded by water. In 1994, three nests were located while in 1995, four nests were found, and in 1996, five nests were located of which one pair had reconstructed the nest in the same year on a different tree. Four species of nesting trees were identified: *Acacia nilotica* (7 nests), *Acacia leucophloea* (2 nests), *Mitragyna parvifolia* (1 nest), and *Prosopis cineraria* (2 nests). *Acacia nilotica* was most commonly used among all the tree species and all nests were on the top canopy, 12-15 m high. Some of the trees used for nesting were covered with climbers such as *Cryptostegia grandiflora*. This species with its thorn and dense growth provides good support and protection to the nest from potential predators, such as Jungle Cat *Felis chaus*. Nest dimensions could not be taken for each nest owing to the height of the tree while some nests were constructed on an inaccessible branch. The mean nest depth was 133.84 ±32.66 cm, mean length was 109.3 ±39.99 cm, and mean breadth was 19.5 ±12.62 cm (mean ±s.d.).

Both the sexes of Black-necked Stork participated in bringing nesting material, like *Cryptostegia grandiflora*, tufts of *Vetiveria zizanioides*, *Acacia nilotica*, *Mitragyna parvifolia*, grasses like *Paspalum distichum*, and a few bulbs of water hyacinth *Eichhornia crassipes*.

Nest-site selection in White-necked Stork

The principal component analysis for nest-site characteristics in White-necked Stork extracted three factors with Eigen values greater than 1.0. Loading of nest site characteristic variables on the three components can be interpreted as the relative importance of different factors. The first three components explained 98% of the total variation in nest site selection (Table 1), while the first component accounted for 51% of the total variance. The first component has high positive loadings for GBH (trees with high basal area), water sources outside the Park, and distance to road and distance to the Park boundary from the nesting tree (e.g., protection from disturbance). The second component accounted for an additional 36% of the total variance. This component has high loadings for canopy spread (e.g., dense foliage), distance to nest of other species and water source inside the Park (e.g., shorter distances to feeding sites). The third component accounted for 11% of the total variance. On this component, tree height was highly positively correlated.

Nest-site selection in Black-necked Stork

Principal component analysis performed on all the variables showed three main factors (Table 2). The first three principal components explained 70% of the variation in nest site characteristics. The first component accounted for 30% of the total variance. The first principal component has high loadings for canopy spread, GBH, distance to road, distance to nest, and tree height. These high values suggest that the most important factors are size of the tree and avoidance of disturbance around the nesting site. The second component accounted for an additional 27% of the total variance. This component has high loading for land area, park boundary and distance to road. The high values correspond to increase in distance to land area and from the Park boundary to avoid disturbance by villagers. The third component accounted for 13% of the total variance. The water level is highly positively correlated on the third component, but no single factor made a prominent contribution.

Difference between nesting and non-nesting trees of Black-necked and White-necked Storks

In both the species, t-tests showed significant difference between height, canopy spread, and GBH of nesting and non-nesting trees. Nesting and non-nesting trees differed highly significantly for both species

Table 1: Principal Component Analysis results of habitat variables of White-necked Stork nest site

Habitat Variables	Principal Components		
	I	II	III
Tree Height	-0.555	0.608	0.568
Canopy spread	-0.017	0.834	-0.551
Girth at breast height	0.922	-0.004	-0.384
Water source	-0.291	0.948	-0.049
Park boundary	0.960	-0.006	0.279
Distance to road	0.898	0.413	0.153
Distance to nest	0.460	0.878	0.047
Water source outside the Park	0.955	-0.144	0.258
Explained Variance	51.1	36.5	11.8
Cumulative Percent Variation Explained	51.1	87.6	99.4

Table 2: Principal Component Analysis results of habitat variables of Black-necked Stork nest site

Habitat Variables	Principal Components		
	I	II	III
Tree Height	0.544	-0.592	0.196
Girth at breast height	0.774	-0.089	0.531
Canopy spread	0.817	-0.130	0.101
Water source	0.474	-0.330	-0.368
Land area	0.411	0.774	-0.252
Park boundary	-0.247	0.827	0.039
Water source outside	0.443	0.429	-0.567
Distance to road	0.612	0.677	0.144
Distance to nest	-0.633	-0.010	0.097
Water depth	-0.132	0.544	0.671
Explained Variance	30.0	27.0	13.3
Cumulative Percent Variation Explained	30.0	57.0	70.3

(see details in Table 3). We found that most of the nesting trees were significantly taller and bigger than the non-nesting trees.

DISCUSSION

In both species, nest-site selection involves a joint selection by male and female (Ishtiaq 1998). In both species, the major factors for selecting the nesting sites were found to be tree height, GBH and the canopy spread. All the nesting trees were tall with large GBH and dense canopy spreads, which provided protection from predation. The nests of Black-necked Stork were on the top canopy, from where most of the surrounding area was visible, and from which take-off and landing for these large birds was easy. This contrasts with the White-necked Stork, which preferred to nest in the middle, dense and hidden strata of the tree. The nesting trees of the White-necked Stork were mostly surrounded by the *Acacia nilotica* woodland and flooded grasslands.

All the nests of White-necked Stork found in the Park were located on *Mitragyna parvifolia* trees, while outside the Park *Dalbergia sissoo* was used. The main reason for this could be that the wood of *Mitragyna parvifolia* is used by locals for many purposes and therefore has a high market value; hence it is not common outside the Park. In fact, due to its high commercial value it has often been illegally removed from the Park. Nests of the White-necked Stork on *Mitragyna parvifolia* are well hidden, as its foliage is denser than that of *Dalbergia sissoo*. Given a chance, the storks would nest on *Mitragyna parvifolia*, but in its absence outside the protected area, *Dalbergia sissoo* was the alternative as it had the advantage of height.

The Black-necked Stork uses *Acacia nilotica* probably due to the presence of thorns, which makes its nests inaccessible to many predators. Whenever *Mitragyna parvifolia* was selected as a nesting-site, the trees were either very tall or dense or covered by the climber *Cryptostegia grandiflora* that has dense thorns. Their nests were located on an inaccessible branch, making them difficult for any ground predator to reach.

The selection of nest-site is an important task in solitary as well as colonial breeders. Solitary breeders have different strategies for avoiding risk of predation and thus selection of safe nesting sites is important for successful breeding (Frederick and Collopy 1989).

As expected, water level is a significant factor in determining the nest-site selection in Black-necked Stork. One pair of Black-necked Storks was observed attempting to nest in the Ajanbund area for two

Table 3: Comparison between nesting and non-nesting trees of Black-necked Stork and White-necked Stork

Tree Variables	Nesting Tree*	Non-Nesting Tree*	P Value
	Black-necked Stork		
	(n=12)	(n=95)	
Tree Height	908.33 ±71.20	671.68 ±23.61	0.0012
Tree GBH	183.33 ±20.55	104.93 ±5.97	0.000
Canopy Spread	761.6 ±179.81	410 ±29.24	0.0009
	White-necked Stork		
	(n=15)	(n=45)	
Tree Height	329.66 ±162.40	113.85 ±184.59	0.0552
Tree GBH	650 ±151.65	208.88 ±174.28	0.0000
Canopy Spread	483.33 ±421.50	642.22 ±135.66	0.0090

*All values are in cm
Values are mean ±s.d.
P value for t-test comparing nesting and non-nesting trees

consecutive years during monsoon. As soon as the water was drained, the pair abandoned the nest and selected another site. Presence of water around the nesting tree reduces the risk of predation by ground predators like the Jungle Cat *Felis chaus*. It also reduces the accessibility to locals who frequently visit the Park to cut grass, sometimes very close.

Presence of water around the nesting sites of White-necked Stork was not important, as they need shallow water sites for foraging. During the initial months of nesting, water was found around all the nesting trees, but it gradually dried up by the time chicks had fledged and were ready to leave the nest. Another reason could be that birds usually prefer their nesting sites within the foraging site so as to reduce the number of trips to the nest. Closer feeding sites also help in increased vigilance of the nest and minimise chances of predation.

The relationship between changes in water level and foraging of wading birds has been demonstrated for a number of species (Kushlan 1978). The Wood Stork *Mycteria americana* started nesting when the water reached a certain level (Kahl 1964). In the White-necked Stork, nest-site selection and egg-laying occur before the onset of the monsoon when the water level is ideal for foraging inside the Park. But soon after the rains when the area is flooded, the foraging site is affected, as this species needs shallow feeding grounds.

Some nests of White-necked Stork were found near the Park boundary, which was perhaps due to the preference for feeding areas outside the Park. These are shallow water bodies like roadside puddles and pools, and provide ample opportunity to the stork to increase its foraging efficiency as the nesting coincides with the time of release of water inside the Park. The release of water results in a sudden rise in its level, disturbing the traditional foraging sites of many shallow water birds, forcing them to move out in search of food which is easily found along the roadside puddles and pools. These small waterbodies provide an ideal habitat for the White-necked Stork as well.

Nest predation has a significant role in the evolution of many aspects of avian nesting behaviour (Lack 1968, Burger 1982). Among Ciconiiformes, there is almost no group or individual nest defence behaviour, and even low predation is apparently capable of destroying very large colonies (Baker 1940; Sheilds and Parnell 1986; Rodgers 1987). We never saw predation on Black-necked and White-necked Stork nests during the study period. White-necked Storks nest during the monsoon, when no migratory raptor species is present, and by the time the large raptors (Greater Spotted Eagle *Aquila clanga*, Eastern Imperial Eagle *Aquila heliaca*) start coming, stork chicks are fledged and leave their nesting sites. Late-nesting storks often suffer loss of chicks by eagle predation, this has been reported by Naoroji (1990) and observed by us several times in the colony of Painted Storks *Mycteria leucocephala*.

In Keoladeo National Park, the abundance of food and near absence of raptors during summer, and the controlled regulation of the water level in the wetland (blocks) help in successful breeding of the storks each year. For nesting trees, which were not surrounded by water, there was no potential predator for the White-necked Storks except perhaps the Jungle Cat. We never observed any mortality due to predation on this solitary species.

There was intraspecific eompetition for nest-sites in the Park, and the White-backed Vulture *Gyps bengalensis* was the only other species directly competing with storks for nest-sites. For two years, a pair of Black-necked Stork was forced to leave a half-constructed nest due to the presence of vultures. In the case of White-necked Stork as well, vultures once successfully expelled the storks from the selected site (Ishtiaq 1998).

Birds often re-use their nesting site based on their past experiences (Butler 1993). We found that two nests were re-used by the White-necked and Black-necked Stork in consecutive years.

Bird populations are regulated by territorial behaviour (Lack 1968; Fretwell and Lucas 1970; Patterson 1980). Based on the movement of individuals, it was found that the Black-necked Stork is a highly territorial bird, and a pair does not allow other pairs or solitary individuals in its territory. A nearly stable population of six adult pairs of Black-necked Storks and the presence of sub-adults during the non-breeding season in the Park suggests that all the potential territories are already occupied and there would be quick replacement if an individual or a pair disappears or dies.

Based on the ecology of Black-necked and White-necked Storks, it can be concluded that the two species utilise different habitats owing to their feeding preferences and behaviour. The Black-necked preferred to nest slightly later in the season when the food supply was plentiful and prey were large. They also nested on tall trees with high Girth at Breast Height (GBH) and canopy to support a comparatively large platform for the nest. The nesting ecology of the White-necked Stork is different, as it prefers to feed on small food items in shallow water bodies (sites that are numerous soon after the monsoon) and the nests are usually made in the middle, dense part of the tree with high GBH.

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LIFE HISTORY PARAMETERS AND LARVAL PERFORMANCE OF SOME SOUTH INDIAN BUTTERFLY SPECIES[1]

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Life history parameters, such as pattern of egg laying, hatching, larval and pupal period and the total period from egg to emergence of adult of 14 butterfly species, distributed at Visakhapatnam are described. Larval performance with respect to consumption index (CI) and growth rate (GR), and estimation of nutritional indices like approximate digestibility (AD), efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) is presented.

Acraea terpsicore and *Anaphaeis aurota* lay eggs in clusters, and the other 12 species lay single eggs. The hatching, larval and pupal periods, and ultimately the total period for the development of egg to the emergence of adult are longer (40-48 days) in *Pachliopta hector* and *P. aristolochiae* than in other Papilionids, and taxonomic groups. The larvae of each of the 14 species pass through five instars, and the last two instars have a major share of the total food consumed over the entire larval period. The consumption index (CI) values of these two instars ranged from 0.60 to 3.50. Among the five instars, the first shows the highest CI in all the 14 species and the values tend to decrease progressively through the successive instars. The AD values and food consumption are inversely related. The AD value is highest in the first instar and lowest in the fifth instar, the values ranging from 86 to 99.5%. The ECD values show a general decrease from the early to the late instars. The ECI values range from 19-60% for *Anaphaeis aurota* and from 2-34% for others, with most falling between 10% and 20%.

Key words: Butterflies, life history, larval performance, nutritional indices, conservation

INTRODUCTION

Over billions of years, evolution has established a balance in the ecological functioning of various organisms. However, as human societies developed and flourished, considerable disturbance and destruction of habitats of various organisms, resulted in the decline and extinction of several species. Butterflies considered as beneficial insects are no exception to the adverse effects of human civilizations. They are important natural resources as they (1) help in pollination, a key process in natural propagation, (2) are important ecological indicators as they are closely associated with plants both as adults and as larvae, (3) have an important place in the web of life, and (4) enhance the aesthetic value of the environment by their exquisite wing colours. Hence, there is an increasing global interest in conserving and managing butterflies (New *et al.* 1995). A complete understanding of the requirements of butterflies is the key to their successful conservation and management, but such knowledge on Indian butterflies is woefully inadequate (Gay *et al.* 1992).

Butterflies are holometabolous, and their reproductive output depends on the combined effect of larvae and adult derived nutrients (Boggs 1981). Therefore, detailed life history studies to assess the performance of larvae with respect to food consumption, utilisation and growth are necessary. Here, we report the results from assays of pre-adult stages (egg, larva, pupa and egg to adult), and the food consumption, utilisation and growth indices of larvae of 14 butterfly species based on laboratory studies conducted in the Andhra University, Visakhapatnam.

METHODS

Study Locality:

The present study was carried out from 1996-1998 at Visakhapatnam, located on the east coast of India in the State of Andhra Pradesh between 17° 42' N and 82° 18' E. The climate is typically coastal, dominated by two monsoons, the southwest (June-September) and the northeast (December-February). The period from October through November is cyclone prone. Total annual rainfall ranges between 100-150 cm with most of the precipitation occurring during June-October. The maximum temperature varies between 35-40 °C experienced mostly in May-June, and the minimum between 18-20 °C experienced mostly in January-February. During the rainy season, many herbs and shrubs appear, and the suburban vegetation is mainly deciduous scrub jungle. The whole area is subject to human disturbance because of urban expansion.

Breeding season, oviposition and larval host plants of the butterflies were observed at two sites: (1) the Andhra University campus spread over 0.5 sq. km, it enjoys both wild and cultivated flora, and (2) the Indira Gandhi Zoological Park and its neighbourhood with semi-protected forest area, spread over one sq. km. Representative samples of butterflies were collected at 10 day intervals from both the sites, by stalking or chasing the fast flying species or by gently sweeping the low flying species. The specimens collected were identified from Wynter-Blyth (1957); Varshney (1980, 1985) was referred to for nomenclature. For each of the 14 butterflies species of the present study, ovipositing activity was observed and larval host plants recorded.

Laboratory study

Life History: The breeding females were watched during the breeding season, and the fresh eggs laid were collected in petri dishes (9.5 cm diameter) along with the plant material on which they were laid. These were incubated at room temperature (*c.* 28 °C) in the laboratory. Irrespective of the number of eggs laid, only one leaf was kept in each petri dish and watched at 6 hour intervals to record the hatching time. The intervals were shortened if necessary after preliminary observations. The larvae that hatched were also observed at fixed intervals for moulting until they pupated. Based on the number of moults, the number of instars for each species was determined. As the larvae completed their first or second instar stage, each was maintained in a larger petri dish (15.5 cm) to facilitate free movement. The egg, individual larval instar, pupal and egg to adult duration were recorded. Five replicates were maintained for each species.

Food consumption and utilisation: Food was changed daily and the petri dishes were kept clean by removing the food remains and faecal matter, which were later weighed and disposed of. For every instar, its initial and final weight was taken and the weight gain noted. After preliminary observations of food consumed by the larvae, 5-10 leaves were weighed and given to the larvae. The total food consumed by the larvae was calculated at the end of each instar period. Mean and standard deviations were estimated for food consumed, weight of faeces and weight gained by the larvae. The following parameters were estimated as in Waldbauer (1968).

$$\text{CI (Consumption index)} = \frac{\text{Wt. of food consumed}}{\text{Wt. of instar x Number of feeding days}}$$

$$\text{GR (Growth rate)} = \frac{\text{Wt. gain of instar}}{\text{Mean Wt. of instar x Number of feeding days}}$$

$$\text{AD (Approximate digestibility)} = \frac{\text{Wt. of food consumed - Wt. of faeces}}{\text{Wt. of food consumed}} \text{ x 100}$$

$$\text{ECD (Efficiency of conversion of digested food)} = \frac{\text{Wt. gain of instar}}{\text{Wt. of food consumed - Wt. of faeces}} \text{ x 100}$$

$$\text{ECI (Efficiency of conversion of ingested food)} = \frac{\text{Wt. gain of instar}}{\text{Wt. of food consumed}} \text{ x 100}$$

RESULTS AND DISCUSSION

In all, 14 butterfly species have been examined for their oviposition, plant species used for ovipositing, and pattern of egg laying (Table 1). Egg, larval and pupal duration, and total egg to adult development time are summarized in Table 2. Food consumption, growth and utilization indices are given Tables 3-8.

Egg laying pattern and hatching duration

Of the 14 species of butterflies studied, 12 species lay single eggs, and the other two in clusters. *Anaphaeis aurota* (Family Pieridae) and *Acraea terpsicore* (Family Acraeidae) are cluster layers. The nymphalid *Junonia lemonias*, the two danaids, the six papilionids and the other three pierids are all single egg layers. Single egg laying habit dominates over cluster laying habit among butterfly species of most geographical areas (Thompson and Pellmyr 1991). Though the number of species examined in the present study is low, this study suggests a similar tendency. Based on the information provided by Ford (1957), Stamp (1980) estimated that 2.5% of the butterfly species in India are cluster layers, while the others lay single eggs. However, some reports show the influence of ecological conditions on egg laying pattern (Larsen 1988; Davies and Gilbert 1985). As such, a closer study is required on the pattern of egg laying in different ecological situations.

Table 1: List of the 14 butterfly species studied, their oviposition plants and egg laying patterns

Butterfly species	Oviposition plants	Patterns of egg laying
ACRAEIDAE		
Acraea terpsicore	*Hybanthus ennaespermus*	Cluster (4-6)
DANAIDAE		
Danaus chrysippus	*Calotropis gigantea*	Single
Euploea core	*Nerium odorum*	Single
NYMPHALIDAE		
Junonia lemonias	*Asystasia gangetica*	Single
PAPILIONIDAE		
Graphium doson	*Polyalthia longifolia*	Single
Graphium agamemnon		
Pachliopta hector	*Aristolochia indica*	Single
Pachliopta aristolochiae	*Aristolochia bracteolata*	Single
Papilio polytes	*Murraya koenigii*	Single
Princeps demoleus	*Citrus limon*	Single
PIERIDAE		
Colotis danae	*Cadaba fruticosa*	Single
Anaphaeis aurota	*Capparis spinosa*	Cluster (15-55)
Catopsilia pyranthe	*Cassia siamea*	Single
Eurema hecabe	*Cassia tora*	Single

According to Chew and Robbins (1984), the species with a single egg laying habit generally use small plants as larval hosts, but this is not true in *Acraea terpsicore* which lays eggs in clusters of 4-6 on the herbaceous *Hybanthus ennaespermus*. While single egg laying habit is advantageous to exploit isolated plants, preventing the possibility of larval starvation, egg clustering improves larval host resource exploitation (Davies and Gilbert 1985).

The hatching or incubation period is 3-4 days in 9 of the 14 species, 4-5 in 3 species, and 6-7 days in 2 species. In temperate species, the hatching period is reported to differ between cluster and single egg layers, the former being longer (Stamp 1980). Such a difference is not apparent in these 14 tropical species. In fact, *Pachliopta hector* and *P. aristolochiae* that lay single eggs have a longer incubation period of 6-7 days than the cluster laying *Acraea terpsicore* (3-4 days) and *Anaphaeis aurota* (4-5 days). It thus appears that the incubation period may depend on the size of the egg rather than on the egg laying pattern, the bigger eggs taking a relatively longer period. This requires to be tested under similar conditions of incubation.

Larval and pupal duration, and total development time

The durations of the different instars of the 14 butterfly species appear to be similar. The duration of instar I varied between 2-3 days, of instar II and III each 2-4 days, of instar IV 2-5 days, and instar V 3-7 days. Only the fifth instar of two papilionids *Pachliopta hector* and *P. aristolochiae* have a relatively longer duration of 6-7 days. The total larval period ranged between 11-20 days. The pupal period of six species, namely *Acraea terpsicore*, *Danaus chrysippus*, *Junonia lemonias*, *Anaphaeis aurota*, *Catopsilia pyranthe* and *Eurema hecabe* was short ranging from 6-8 days, and the remaining eight species had a longer period of 9-16 days. The period of egg to adult development time also had two groups, one showing a shorter period of 20-30 days and the other a longer period of 25-48 days (Table 2). The longest period was for *Pachliopta aristolochiae* (40-48 days), and for *P. hector* (39-47 days), and the shortest period of 20-27 days was observed in *Junonia lemonias* and *Eurema hecabe*. In Papua New Guinea, the world's largest butterfly *Ornithoptera alexandrae* (Papilionidae) has an egg to adult development time spanning over 122 days (Parsons 1984c), the lycaenids *Philiris helena*, *P. agatha*, *P. intensa* and *P. zisk* have 30 days each (Parsons 1984a). The nymphalid *Taeniaris myops* has 54 days, and *T. arotaus* 60 days (Parsons 1984b). Relevant data from other regions in India are required for a meaningful comparison and interpretation. However, temperature influences instar duration

Table 2: Duration in days of different stages in the life history of the 14 butterfly species under study

Butterfly species	Hatching period	Instar duration					Larval duration	Pupal duration	Duration of egg to adult development
		I	II	III	IV	V			
ACRAEIDAE									
A. terpsicore	3-4	2-3	3-4	3-4	3-4	4-5	15-20	7-8	25-32
DANAIDAE									
D. chrysippus	4-5	2-3	2-3	2-3	2-3	3-4	11-16	6-7	21-28
E. core	4-5	2-3	3-4	3-4	3-4	3-4	14-19	10-11	28-35
NYMPHALIDAE									
J. lemonias	3-4	2-3	2-3	2-3	2-3	3-4	11-16	6-7	20-27
PAPILIONIDAE									
G. doson	3-4	2-3	2-4	3-4	3-4	4-5	14-20	13-14	30-39
G. agamemnon	3-4	2-3	3-4	3-4	3-4	4-5	15-20	10-11	28-35
P. polytes	3-4	2-3	3-4	3-4	3-4	3-4	14-19	10-11	27-35
P. demoleus	3-4	2-3	3-4	3-4	3-4	3-4	14-19	10-12	27-35
P. hector	6-7	2-3	3-4	3-4	4-5	6-7	18-23	15-17	39-47
P. aristolochiae	6-7	2-3	3-4	3-4	4-5	6-7	18-23	16-18	40-48
PIERIDAE									
C. danae	3-4	2-3	2-3	2-3	2-3	3-4	11-16	9-10	23-30
A. aurota	4-5	2-3	2-3	2-3	2-3	3-4	12-16	6-7	21-28
C. pyranthe	3-4	2-3	2-3	2-3	2-3	3-4	12-16	7-8	21-29
E. hecabe	3-4	2-3	2-3	2-3	2-3	3-4	11-16	6-7	20-27

Table 3: Instarwise food consumption and growth of 14 butterfly species

Butterfly species	Instar number	wt. of food consumed (mg)	wt. of faeces (mg)	wt. gain of larva (mg)
Acraea terpsicore	I	17.0 ± 0.21	0.5 ± 0.01	1.2 ± 0.08
	II	138.0 ± 0.42	3.9 ± 0.12	15.5 ± 0.21
	III	563.0 ± 4.70	18.2 ± 0.25	68.0 ± 0.28
	IV	1068.5 ± 9.20	132.8 ± 0.91	152.5 ± 0.94
	V	2840.0 ± 16.70	408.0 ± 2.90	402.0 ± 3.10
Danaus chrysippus	I	18.0 ± 0.08	0.1 ± 0.4	0.6 ± 0.02
	II	54.0 ± 1.40	3.7 ± 0.32	7.0 ± 0.7
	III	382.5 ± 3.40	15.6 ± 0.97	53.0 ± 1.20
	IV	1210.0 ± 6.14	98.0 ± 1.90	208.0 ± 3.10
	V	2972.0 ± 14.2	458.0 ± 4.20	417.0 ± 3.90
Euploea core	I	34.0 ± 0.21	0.65 ± 0.04	3.40 ± 0.21
	II	208.0 ± 1.40	4.8 ± 0.37	23.2 ± 0.41
	III	585.5 ± 2.10	49.2 ± 0.61	121.0 ± 0.74
	IV	1377.5 ± 6.70	231.4 ± 1.91	471.3 ± 2.1
	V	4125.5 ± 13.20	612.5 ± 4.3	665.3 ± 4.8
Junonia lemonias	I	35.1 ± 0.41	0.31 ± 0.21	3.15 ± 0.18
	II	254.3 ± 0.74	3.80 ± 0.21	27.00 ± 0.30
	III	723.7 ± 6.30	4480 ± 0.41	351.0 ± 0.94
	IV	1759.0 ± 12.40	181.50 ± 0.72	600.40 ± 5.70
	V	4656.2 ± 20.20	594.40 ± 5.10	701.00 ± 6.40
Graphium doson	I	21.6 ± 0.34	0.15 ± 0.09	2.2 ± 0.10
	II	88.50 ± 0.84	3.42 ± 0.18	18.0 ± 0.21
	III	1397.5 ± 8.40	110.5 ± 0.19	222.6 ± 1.80
	IV	2371.6 ± 11.2	194.5 ± 1.90	321.3 ± 2.40
	V	3497.3 ± 16.40	528.2 ± 5.30	678.4 ± 3.80
Graphium agamemnon	I	26.5 ± 0.92	0.12 ± 0.04	2.36 ± 0.18
	II	78.3 ± 2.10	3.08 ± 0.24	13.5 ± 0.67
	III	1413.0 ± 7.20	109.50 ± 2.9	206. 3 ± 3.70
	IV	2390.5 ± 12.40	186.4 ± 3.2	267.4 ± 3.90
	V	2733.5 ± 13.60	486.5 ± 4.1	518.8 ± 4.50
Pachliopta hector	I	47.5 ± 0.12	0.30 ± 0.02	2.5 ± 0.06
	II	93.5 ± 0.19	4.21 ± 0.08	19.7 ± 0.12
	III	1426.3 ± 1.20	122.80 ± 0.20	71.0 ± 0.14
	IV	2189.7 ± 4.20	189.50 ± 0.23	453.1 ± 0.41
	V	4320.6 ± 12.40	540.10 ± 0.41	1232.0 ± 1.10
Pachliopta aristolochiae	I	26.2 ± 0.98	0.32 ± 0.02	2.2 ± 0.18
	II	159.1 ± 1.90	3.40 ± 0.31	16.0 ± 0.71
	III	394.3 ± 2.70	18.60 ± 0.92	68.6 ± 1.41
	IV	1003.2 ± 5.10	72.40 ± 1.21	319.09 ± 2.30
	V	4757.3 ± 21.20	882.20 ± 4.40	1425.8 ± 6.30
Papilio polytes	I	31.0 ± 0.92	0.21± 0.02	3.21 ± 0.19
	II	154.3 ± 2.70	3.90 ± 0.27	19.60 ± 0.31
	III	482.7 ± 3.90	61.40 ± 1.40	150.30 ± 2.90
	IV	1683.0 ± 6.10	126.20 ± 1.40	256.80 ± 3.10
	V	2714.2 ± 9.70	375.80 ± 3.90	452.90 ± 3.60

Table 3: Instarwise food consumption and growth of 14 butterfly species (*contd.*)

Butterfly species	Instar number	wt. of food consumed (mg)	wt. of faeces (mg)	wt. gain of larva (mg)
Princeps demoleus	I	40.3 ± 0.21	0.19 ± 0.02	3.87 ± 0.10
	II	113.0 ± 0.80	4.20 ± 0.19	22.80 ± 0.19
	III	1546.0 ± 2.90	119.80 ± 0.82	302.50 ± 1.70
	IV	2474.1 ± 6.10	322.40 ± 1.90	478.30 ± 2.10
	V	4524.2 ± 14.50	818.60 ± 4.80	840.70 ± 4.20
Colotis danae	I	4.2 ± 0.13	0.10 ± 0.01	0.19 ± 0.02
	II	10.2 ± 0.21	0.34 ± 0.04	1.52 ± 0.08
	III	29.6 ± 0.34	6.10 ± 0.18	3.70 ± 0.18
	IV	98.1 ± 0.84	12.60 ± 0.24	13.70 ± 0.34
	V	308.4 ± 3.20	74.60 ± 0.64	59.00 ± 0.51
Anaphaeis aurota	I	4.1 ± 0.12	0.12 ± 0.01	2.47 ± 0.08
	II	43.0 ± 0.21	2.10 ± 0.08	8.29 ± 0.17
	III	129.8 ± 1.02	18.20 ± 0.14	57.25 ± 0.29
	IV	254.5 ± 2.70	52.50 ± 0.31	120.70 ± 1.01
	V	346.5 ± 3.10	196.20 ± 1.90	301.00 ± 2.90
Catopsilia pyranthe	I	4.40 ± 0.12	0.09 ± 0.01	0.10 ± 0.3
	II	42.00 ± 0.18	1.20 ± 0.08	1.70 ± 0.09
	III	260.00 ± 2.40	21.50 ± 0.14	24.50 ± 0.16
	IV	350.00 ± 3.60	62.90 ± 0.22	32.50 ± 0.17
	V	1339.00± 7.40	421.00 ± 3.90	141.00 ± 0.38
Eurema hecabe	I	6.0 ± 0.08	0.04 ± 0.02	0.06 ± 0.01
	II	48.0 ± 0.02	1.20 ± 0.08	2.87 ± 0.06
	III	232.0 ± 0.24	12.90 ± 0.09	36.60 ± 0.11
	IV	251.5 ± 0.26	29.10 ± 0.10	37.70 ± 0.11
	V	313.0 ± 0.32	60.20 ± 0.17	56.50 ± 0.18

(Palanichamy *et al.* 1982) and the overall developmental time from egg to adult (Owen 1971). Hence, the larval and pupal duration, and egg to adult development time of these 14 butterfly species in other regions may vary according to the prevailing weather conditions. The present data, however, agrees with Owen (1971), who states that egg to adult development time is much shorter in the tropics.

Food consumption and utilization

The data on the proportion of food consumed by the five instars of each of the 14 butterfly species indicates that the fourth or fifth instar had a major share of the total amount of food consumed over the entire larval period. Similar findings have been reported for other species (David and Gardiner 1962; Waldbauer 1968; Mathavan and Pandian 1975; Scriber and Slansky 1981; Palanichamy *et al.* 1982; Selvasundaram 1992; Ghosh and Gonchaudhuri 1996). The increase in consumption might be a strategy to compensate for the energy requirement in the non-feeding pupal stage (Delvi and Pandian 1972; Pandian 1973). The consumption index (CI) of instar I is the highest in all the 14 species, and CI decreases progressively across the instars. CI depends on the conversion efficiency of the food consumed (ECI) (Slansky and Scriber 1985), and is inversely proportional to ECI. Thus, the high CI of instar I of all the 14 butterfly species may be because of low conversion efficiency (ECI) (Table 4). The values of consumption index (CI) of any instar of the 14 species are within the ranges reported for Lepidoptera in general (Slansky and Scriber 1985) and correspond well with the values of swallowtails (Scriber and Feeny 1979; Scriber 1986).

The value of GR of the 14 butterfly species decreased progressively in general and was highest in instar I, and lowest in instar V (Table 5). A similar trend has been recorded for the moth *Pericallia ricini* (Ghosh and Gonchaudhuri 1996). Penultimate instars had a higher growth rate than the final instars in some swallowtails and moths (Scriber and Feeny 1979). The GRs of penultimate and final instars now obtained are in line with the above decreasing trend. The larvae reared on tree foliage show higher growth rates than the larvae

Table 4: Values of Consumption Index (CI) for successive instars of 14 butterfly species

		CI				
Butterfly Species	Instars	I	II	III	IV	V
ACRAEIDAE						
A. terpsicore		7.47	2.40	3.40	1.80	0.90
DANAIDAE						
D. chrysippus		10.50	2.50	3.70	1.40	0.60
E. core		8.60	2.20	1.90	1.70	0.70
NYMPHALIDAE						
J. lemonias		9.80	6.60	3.50	1.90	2.00
PAPILIONIDAE						
G. doson		9.30	3.50	3.50	1.80	1.30
G. agamemnon		10.00	2.40	2.80	1.40	1.10
P. polytes		18.70	5.00	4.00	3.40	2.00
P. demoleus		14.40	3.12	1.62	0.98	0.65
P. hector		22.00	7.60	2.06	1.70	2.07
P. aristolochiae		16.00	14.60	5.40	1.64	0.93
PIERIDAE						
C. danae		8.30	4.80	1.10	0.84	1.10
A. aurota		10.80	4.79	3.23	1.94	1.99
C. pyranthe		8.10	1.80	4.00	3.50	1.70
E. hecabe		8.70	4.40	2.10	1.10	1.40

Table 5: Values of Growth Rate (GR) for successive instars of 14 butterfly species

		GR				
Butterfly Species	Instars	I	II	III	IV	V
ACRAEIDAE						
A. terpsicore		0.78	0.53	0.39	0.27	0.28
DANAIDAE						
D. chrysippus		0.27	0.24	0.56	0.48	0.23
E. core		0.87	0.49	0.40	0.39	0.22
NYMPHALIDAE						
J. lemonias		0.75	0.52	0.56	0.28	0.17
PAPILIONIDAE						
G. doson		0.57	0.49	0.55	0.25	0.18
G. agamemnon		0.93	0.43	0.55	0.16	0.12
P. hector		0.45	0.45	0.39	0.35	0.20
P. aristolochiae		0.70	0.66	0.62	0.60	0.60
P. polytes		0.96	0.45	0.48	0.27	0.21
P. demoleus		0.96	0.48	0.54	0.27	0.21
PIERIDAE						
C. danae		0.57	0.73	0.49	0.54	0.39
A. aurota		0.87	0.60	0.71	0.46	0.29
C. pyranthe		0.50	0.30	0.20	0.15	0.21
E. hecabe		0.80	0.87	0.81	0.30	0.17

maintained on herbaceous foliage (Scriber and Feeny 1979). The host plant *Polyalthia longifolia* utilised by *Graphium agamemnon* and *G. doson*, and *Citrus limon* utilised by *Papilio polytes* and *Princeps demoleus* are tree species, whereas *Aristolochia indica* and *A. bracteolata* used by *Pachliopta hector* and *P. aristolochiae*, and *Hybanthus ennaespermus* used by *Acraea terpsicore* are herbaceous. While the growth rates of *Pachliopta aristolochiae* larval instars II to V are greater than those of other tree foliage feeders, those of *Pachliopta hector* are not different from other tree foliage feeders, hence the data is considered inadequate to consider the issue of different growth rates on the two kinds of foliage.

The values of approximate digestibility (AD) of the 14 butterfly species declined as the larvae aged (Table 6). The larvae may have consumed a larger proportion of indigestible crude fibre as they grew older which caused AD values to decrease along the successive instars (see Slansky and Scriber 1985). This decrease could also be the reason of the decreased growth rate (GR) described earlier. The AD values are inversely related to the food consumed by different instars. It is highest in instar I, the corresponding percentages of each of the 14 species are: *Pachliopta aristolochiae* 0.41, 98; *P. hector* 0.59, 99; *Papilio polytes* 0.61, 99; *Princeps demoleus* 0.46, 99; *Graphium agamemnon* 0.40, 99; *G. doson* 0.29, 99; *Anaphaeis aurota* 0.53, 97; *Calotis danae* 0.93, 98; *Acraea terpsicore* 0.37, 97; *Catopsilia pyranthe* 0.23, 98; *Eurema hecabe* 0.72, 99; *Junonia lemonias* 0.47, 99; *Danaus chrysippus* 0.39, 97; and *Euploea core* 0.53, 98. The AD is lowest in instar V, the corresponding percentages are *Pachliopta aristolochiae* 75.03, 84; *P. hector* 53.49, 87; *Papilio polytes* 41.15, 86; *Princeps demoleus* 52.02, 82; *Graphium agamemnon* 41.15, 82; *G. doson* 47.41, 84; *Anaphaeis aurota* 44.5, 70; *Calotis danae* 68.5, 76; *Acraea terpsicore* 61.38, 86; *Catopsilia pyranthe* 67.10, 69; *Eurema hecabe* 36.80, 81; *Junonia lemonias* 62.68, 87; *Danaus chrysippus* 64.10, 84; *Euploea core* 65.16, 85. Such a relationship between approximate digestibility and food consumption is also evident from the data compiled by Waldbauer (1968). The AD values of the 14 species ranging between 86.0 to 99.5% appear to be higher than those reported for several lepidopteran larvae (see Pandian and Marian 1986; Ghosh and Gonchaudhuri 1996). The larvae were given tender leaves daily. Tender leaves are usually rich in nitrogen and the larvae may have assimilated them more efficiently resulting in high values of AD. The values of efficiency of conversion of digested food (ECD) showed a general increase from

Table 6: Values of Approximate Digestibility (AD) for successive instars of 14 butterfly species

		AD (%)				
Butterfly Species	Instars	I	II	III	IV	V
ACRAEIDAE						
A. terpsicore		97	97	89	88	86
DANAIDAE						
D. chrysippus		97	93	96	93	84
E. core		98	97	91	83	85
NYMPHALIDAE						
J. lemonias		99	98	93	89	87
PAPILIONIDAE						
G. doson		99	95	92	91	84
G. agamemnon		99	96	92	92	82
P. hector		99	94	92	91	87
P. aristolochiae		98	97	95	92	81
P. polytes		99	97	94	92	86
P. demoleus		99	96	92	87	82
PIERIDAE						
C. danae		98	96	89	85	76
A. aurota		97	95	86	79	70
C. pyranthe		98	97	92	82	69
E. hecabe		99	98	94	86	81

Table 7: Values of Efficiency of conversion of digested food (ECD) for successive instars of 14 butterfly species

		ECD (%)				
Butterfly Species	Instars	I	II	III	IV	V
ACRAEIDAE						
A. terpsicore		8.0	12.0	12.0	16.0	17.0
DANAIDAE						
D. chrysippus		3.4	13.9	14.4	14.7	16.5
E. core		10.2	11.4	23.4	41.3	18.9
NYMPHALIDAE						
J. lemonias		9.0	11.0	6.0	38.0	17.0
PAPILIONIDAE						
G. doson		7.7	20.3	17.2	14.7	22.8
G. agamemnon		2.3	17.9	15.8	12.1	22.9
P. hector		18.8	21.9	5.4	22.6	32.5
P. aristolochiae		8.4	10.2	18.2	34.0	36.0
P. polytes		10.4	13.0	14.7	16.5	19.3
P. demoleus		9.6	20.9	21.2	22.1	22.6
PIERIDAE						
C. danae		3.0	15.0	15.0	18.0	25.0
A. aurota		62.0	20.0	52.0	60.0	64.0
C. pyranthe		2.0	4.0	10.0	11.0	15.0
E. hecabe		1.0	6.0	16.0	19.0	19.0

Table 8: Values of Efficiency of conversion of ingested food (ECI) for successive instars of 14 butterfly species

		ECI (%)				
Butterfly Species	Instars	I	II	III	IV	V
ACRAEIDAE						
A. terpsicore		7.0	11.0	12.0	14.0	14.0
DANAIDAE						
D. chrysippus		3.3	12.9	13.8	13.8	14.0
E. core		10.0	11.5	21.5	34.2	16.0
NYMPHALIDAE						
J. lemonias		9.0	11.0	6.0	34.0	15.0
PAPILIONIDAE						
G. doson		7.7	19.3	15.9	13.5	19.3
G. agamemnon		8.9	17.2	14.6	11.2	18.8
P. hector		5.2	20.9	14.9	20.6	28.5
P. aristolochiae		8.3	10.0	17.0	31.0	29.9
P. polytes		10.3	12.7	13.8	15.2	16.6
P. demoleus		9.6	20.1	19.5	19.2	18.5
PIERIDAE						
C. danae		3.0	14.0	15.0	15.0	19.0
A. aurota		60.0	19.0	44.0	47.0	45.0
C. pyranthe		2.0	4.0	9.0	9.0	11.0
E. hecabe		3.0	6.0	17.0	12.0	23.0

early to late instars, and the values are very low compared to AD values, indicating poor utilisation of the digested food (Table 7).

The values of efficiency of conversion of consumed food (ECI) of *Anaphaeis aurota* ranged between 19-60% and those of the other 13 species varied between 2-34%; most of these values fall between 10% and 20%. These values indicate low conversion efficiency, but are comparable with the ECI values reported for swallowtails (Scriber and Slansky 1981). Excised foliage was used for rearing the larvae, and such foliage is likely to be deficient in water. Since leaf water content is directly related to conversion efficiency (Muthukrishnan 1990) the larvae had to spend energy to produce metabolic water, which may have resulted in low conversion efficiency. While it is indicated that the ECI values across the instars show a decreasing trend, and follow the pattern of decline in AD (Waldbauer 1968), the ECI pattern of the 14 species does not conform to the above relation (Table 8). The ECIs showed definite trend of increase or decrease across the instars, thus supporting the predicted inconsistency in ECI pattern (Slansky and Scriber 1985) also recorded in the moth *Pericallia ricini* (Ghosh and Gonchaudhuri 1996). The various nutritional indices of the 14 butterfly species will enable a proper understanding of the trophic interactions of these species.

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LARVAL FOOD PLANTS OF EMPEROR MOTHS AND HAWKMOTHS OF SANJAY GANDHI NATIONAL PARK, BORIVLI, MUMBAI (LEPIDOPTERA: SATURNIIDAE AND SPHINGIDAE)[1]

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Ecological studies were conducted on the moths of Sanjay Gandhi National Park, with special reference to the Families Saturniidae and Sphingidae. Three species of Emperor moths and 32 species of Hawkmoths were recorded, of these the life histories of 26 species were studied (3 Saturnids, 23 Sphingids). For Family Saturniidae, 10 new larval food plants have been added to the 80 known species for 2 Emperor moths. For Family Sphingidae, 33 new larval food plants have been added to the 111 known species for 20 Hawkmoths. A brief overview of the larval food plants in terms of preferences, abundance and resource sharing are covered in this paper.

Keywords: Saturniidae, Sphingidae, Emperor moths, Hawkmoths, Saturnids, Sphingids, larval food plants, specialists, generalists, indicator species

INTRODUCTION

Ecological studies on the moths of Sanjay Gandhi National Park (SGNP), Mumbai, with special reference to Families Saturniidae and Sphingidae, were conducted from 1993 to 2001. Three species of Emperor moths and 32 species of Hawkmoths were recorded. SGNP is a unique national park, in that it is surrounded by a metropolis like Mumbai. It is constantly under heavy biotic pressure from humans. This National Park lies in the Western Ghats, a crucial area with rich biodiversity. Though most of the flora and fauna have been well documented, very little was known about the insect fauna of the Park. An ecological study of the moths was initiated, for which the Families Saturniidae (Emperor moths) and Sphingidae (Hawkmoths) were selected. Ecological data on the moths of Maharashtra region is scanty, and there are many lacunae in the information on their life histories, including larval food plants, which vary for different habitats. Thus, a food plant recorded for a particular moth species in southern India may differ from that found in western India (e.g. *Carissa carandas*). Detailed life histories of 3 Saturnids and 23 Sphingids were successfully recorded.

Emperor Moths: Family Saturniidae

Saturnids are known as Emperor moths or non-mulberry silkmoths (Arora and Gupta 1979). The largest moth in Asia is a Saturnid, the Atlas moth, with a wingspan of 29 cm. Besides their size and exuberant beauty, they are also known for their non-feeding adults and gregarious caterpillars. Others, like Tasar, Muga and Eri moths are known for silk production and are commercially exploited by the silk industry.

Hawkmoths: Family Sphingidae

Sphingids are also known as Sphinx moths for the sphinx-like posture adopted by the caterpillars when threatened. They are best known for their long migratory flight; some have even been encountered at mid-sea (Kehimkar 1997). The stout, cigar-shaped body and long, narrow forewings of the adult are distinctive. The long proboscis makes Hawkmoths ideal pollinators for flowers which have a long tubular corolla (Barlow 1982).

STUDY AREA

The *c.* 103 sq. km area of SGNP is spread over the Greater Bombay (44.50 sq. km) and Thane (58.64 sq. km) districts of Maharashtra State. It is situated *c.* 40 km north of Mumbai city and *c.* 8 km from the Arabian Sea. The Park has four types of habitats ranging from mangroves to evergreen forests of the Western Ghats. Most of the trees are deciduous, and some evergreen. The forest has diverse flora ranging from tall trees to shrubs and herbs.

Apart from SGNP, the study was also carried out on the adjoining 1.5 sq. km land of the Bombay Natural History Society (BNHS) adjacent to the Goregaon end of the Park. The vegetation on the BNHS land is southern moist-mixed deciduous and the topography is mainly hilly, intersected with rocky streambeds of seasonal rain-fed streams (Patil 1993).

METHODOLOGY

To study the larval food plants, moth caterpillars found in the wild were reared on identified food plants. In the case of generalist (polyphagous) species, the preference levels were also observed. The scattered data on known larval food plants was compiled. Vegetation analysis of the larval food plants in the study area was conducted during two periods, monsoon (July) and non-monsoon (March). The main objectives were: (i) To assess the abundance of larval food plants in the study area in terms of availability for caterpillars, (ii) To grade the food plants as 'very common', 'common' and 'not common' according to their relative abundance.

HOST-PLANT RELATIONSHIPS

According to Scott (1933), the distribution of moths and the number of individuals of any species in any locality, is intimately connected with their choice of food plants, thus the disappearance of a plant may lead to the disappearance of a species feeding on it. Hence, the food plants could be considered as indicator species. According to Speight and Wain House (1989), plants that are abundant and widely distributed host more insect species than plants with restricted distribution. Hence, insect diversity can be broadly predicted from the abundance of a particular plant species. This association indicates that insects and plants have co-evolved in nature. Moreover, host plant selection is governed primarily by chemoreception, therefore, the emergence of specific insect/host plant relationships is most likely to have resulted from evolutionary changes in the insects' chemosensory systems. According to Jermy (1984), adaptation to the nutritional quality of the new host plant is a secondary process.

Some moth species are specialist (monophagous), i.e. they lay eggs on a single plant species only, while others are generalist (polyphagous), i.e. they lay eggs on more than one plant species. Saturnid species tend to be generalists. In the Oriental region, they have been recorded to feed on the following 52 plant families: Anacardiaceae, Annonaceae, Apocynaceae, Aquifoliaceae, Araliaceae, Asclepiadaceae, Barringtoniaceae, Berberidaceae, Betulaceae, Bischofiaceae, Burseraceae, Caricaceae, Combretaceae, Coriariaceae, Corylaceae, Cyperaceae, Daphniphyllaceae, Dilleniaceae, Dipterocarpaceae, Ericaceae, Euphorbiaceae, Fagaceae, Juglandaceae, Labiatae, Lauraceae, Leeaceae, Leguminosae, Lythraceae, Magnoliaceae, Malvaceae, Meliaceae, Moringaceae, Myrsinaceae, Myrtaceae, Naucleaceae, Oleaceae, Oxalidaceae, Palmae, Rhamnaceae, Rosaceae, Rubiaceae, Rutaceae, Salicaceae, Sapindaceae, Simaroubaceae, Staphyleaceae, Symplocaceae, Theaceae, Umbelliferae, Verbenaceae, Vitidaceae and Xanthophyllaceae.

Sphingids are also generalists to some extent. Earlier workers, such as Scott (1933) recorded food plants for 124 species of Sphingids, which cover a wide range of 58 families of plants extending from Dilleniaceae to Gramineae. Family Rubiaceae is the most preferred, with about 30 species feeding on it, followed by Vitaceae and Araceae with 16 species. Further, Beeson (1941) added that altogether 60 families ranging from large trees to herbs and even grasses are larval food plants of Sphingids.

The study recorded 15 larval food plants for 3 Saturnids and 44 for 23 Sphingids. Since 4 larval food plant species were common to both, the total number recorded was 55 plant species belonging to 24 families. Of these, 37 larval food plants from 17 families were new records for 22 moth species (2 Saturnids and 20 Sphingids).

PROFILE OF LARVAL FOOD PLANTS

The diversity of larval food plants in terms of the type (tree, shrub or herb), habit (deciduous or evergreen) and seasonality (perennial or seasonal) is discussed here. It was observed that trees were the most dominant type, followed by shrubs and climbers, while herbs were poorly represented (Fig. 1). 78% of the larval food plants were perennial and 22% were seasonal. Among the perennial larval food plants, 46% were deciduous and 32% were evergreen.

For Saturnids, 15 tree species were identified as larval food plants, of which 73% were deciduous and 27% were evergreen. For Sphingids, 44 plant species were identified, of which 41% were trees, 30% shrubs, 20% climbers and 9% herbs. Among the trees, 39%

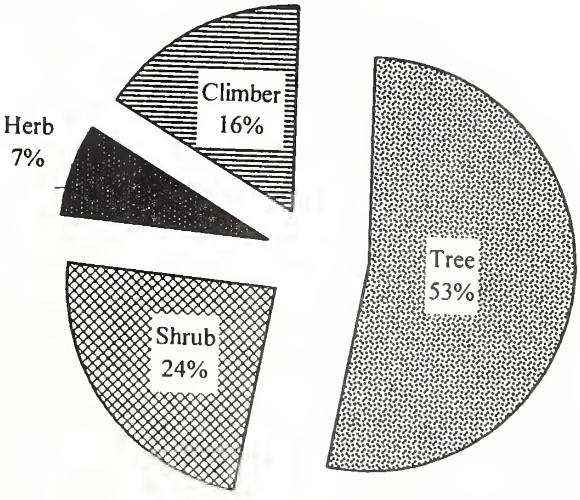

Fig. 1: Profile of larval food plants

Table 1: Larval Food plants/Plant Families and Moth Species

Plant Families	Plant Species	Moth Species
1. Acanthaceae	*Barleria prionitis*	*Acherontia lachesis*
	Carvia callosa	*Acherontia lachesis*
2. Apocynaceae	*Alstonia scholaris*	*Daphnis nerii*
	Carissa congesta	*Nephele hespera*
		Antheraea paphia
	Holarrhena antidysenterica	*Attacus atlas*
	Tabernaemontana coronaria	*Daphnis nerii*
3. Anacardiaceae	*Lannea coromandelica*	*Actias selene*
4. Araceae	*Amorphophallus commutatus*	*Theretra clotho*
		Theretra castanea
		Pergesa acteus
	Arisaema murrayi	*Theretra castanea*
5. Balsaminaceae	*Impatiens balsamina*	*Theretra oldenlandiae*
6. Bignoniaceae	*Oroxylum indicum*	*Psilogramma menephron*
	Spathodea campanulata	*Psilogramma menephron*
7. Bombacaceae	*Bombax ceiba*	*Antheraea paphia*
		Marumba dyras
		Polyptychus dentatus
8. Boraginaceae	*Cordia dichotoma*	*Acherontia lachesis*
		Polyptychus dentatus
9. Burseraceae	*Garuga pinnata*	*Antheraea paphia*
10. Combretaceae	*Anogeissus latifolia*	*Antheraea paphia*
	Terminalia catappa	*Antheraea paphia*
	Terminalia bellerica	*Antheraea paphia*
	Terminalia crenulata	*Antheraea paphia*
11. Convolvulaceae	*Ipomoea sinensis*	*Agrius convolvuli*
	Ipomoea cairica	*Agrius convolvuli*
	Ipomoea carnea	*Acherontia lachesis*
		Agrius convolvuli
	Ipomoea hederacea	*Agrius convolvuli*
	Ipomoea aquatica	*Acherontia lachesis*
		Agrius convolvuli
12. Dioscoreaceae	*Dioscorea hispida*	*Theretra nessus*
13. Euphorbiaceae	*Bridelia retusa*	*Antheraea paphia*
		Marumba dyras
14. Fabaceae	*Pueraria tuberosa*	*Clanis phalaris*
	Dalbergia lanceolaria	*Clanis phalaris*
	Dalbergia latifolia	*Clanis phalaris*
	Pterocarpus marsupium	*Clanis phalaris*
15. Leeaceae	*Leea asiatica*	*Theretra clotho*
		Theretra lycetus
		Pergesa acteus
	Leea macrophylla	*Theretra lycetus*
16. Lythraceae	*Lagerstroemia speciosa*	*Attacus atlas*
	Lagerstroemia lanceolata	*Attacus atlas*
17. Nyctaginaceae	*Boerhavia diffusa*	*Hippotion boerhaviae*
18. Oleaceae	*Nyctanthes arbor-tristis*	*Acherontia lachesis*
19. Rhamnaceae	*Zizyphus mauritiana*	*Antheraea paphia*
	Zizyphus rugosa	*Antheraea paphia*
20. Rubiaceae	*Catunaregam spinarum*	*Cephanodes hylas*
	Gardenia florida	*Cephanodes hylas*
	Gardenia lucida	*Cephanodes hylas*
	Haldina cordifolia	*Cephanodes hylas*
	Hymenodictyon orixense	*Cephanodes hylas*
	Mitragyna parvifolia	*Attacus atlas*
		Cephanodes hylas
	Morinda tinctoria var. *tomentosa*	*Neogurelca hyas*
		Macroglossum belis
		Macroglossum gyrans
		Macroglossum sitiene
		Macroglossum particolor
		Theretra alecto
	Pavetta crassicaulis	*Cephanodes hylas*
	Pavetta siphonantha	*Cephanodes hylas*
	Spermadictyon suaveolens	*Macroglossum gyrans*
21. Solanaceae	*Solanum violaceum*	*Acherontia lachesis*
22. Sterculiaceae	*Firmiana colorata*	*Marumba dyras*
		Marumba indicus
	Helicteres isora	*Marumba dyras*
23. Tiliaceae	*Grewia inequalis*	*Marumba dyras*
24. Vitaceae	*Ampelocissus latifolia*	*Theretra clotho*
		Theretra alecto
		Theretra oldenlandiae
	Cayratia triflora	*Theretra clotho*
	Cissus elongata	*Theretra clotho*

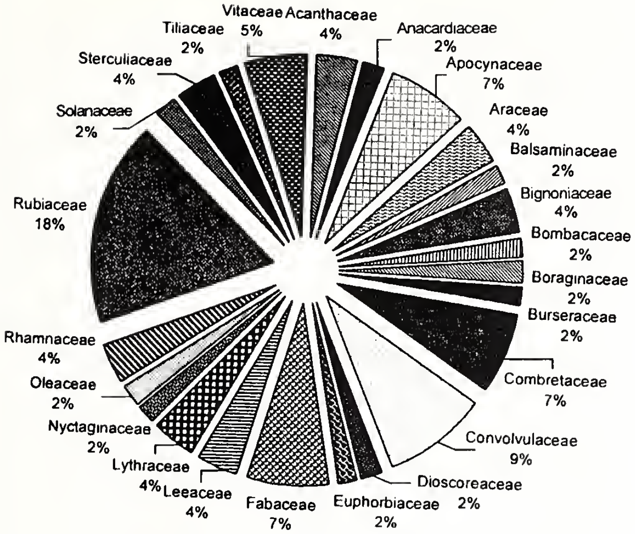

Fig. 2: Families of larval food plants

were deciduous, 34% evergreen and 27% annuals including climbers and herbs. The list of all recorded larval food plants along with their families and moth species is given in Table 1.

It can be summarised from Table 1 that of the listed 24 plant families of larval food plants:

- 11 families had only one host plant species
- 7 families had 2 species
- 3 families had 4 species
- 3 families had 3, 5 and 10 species respectively.

Family Rubiaceae was the largest, with 10 plant species supporting 8 species of Sphingids and 1 Saturnid (see Fig. 2).

RESOURCE SHARING

Resource sharing, i.e. utilization of larval food plants by the moth species is described here. From Table 1 it can be concluded that of the 24 plant families foraged by Saturniidae and Sphingidae (subfamilies Sphinginae and Macroglossinae), 10 families were foraged by Saturniidae (3 species) while 16 plant families were foraged by subfamily Sphinginae (9 species) and 23 by Macroglossinae (14 species). Both Saturnids and Sphingids shared four plant families, Apocynaceae, Bombacaceae, Boraginaceae and Rubiaceae. The data showed that Sphingids utilized 81% of the resources, while Saturnids used only 19%. Among the subfamilies of Sphingids, Macroglossinae accounted for 48%, and Sphinginae 33%.

LARVAL FOOD PLANT PREFERENCES

Most of the Saturnid and Sphingid caterpillars were generalist feeders, but a few species behaved like specialist feeders, in that they fed only on one host plant, despite the availability of their known food plants in the area. Such species are termed as 'acting specialist' here, and there were two categories among them:

1. Moth species that preferred to lay eggs on a single larval food plant, ignoring the other known food plants found in the study area.

Table 2: List of Generalist and Specialist Species

Generalist Species	Specialist Species	Acting Specialist Species
FAMILY SATURNIIDAE		
1. *Attacus atlas* 2. *Antheraea paphia*	1. *Actias selene*	None
FAMILY SPHINGIDAE SUBFAMILY SPHINGINAE		
1. *Agrius convolvuli* 2. *Acherontia lachesis* 3. *Psilogramma menephron* 4. *Clanis phalaris* 5. *Polyptychus dentatus* 6. *Marumba dyras*	None	1. *Marumba indicus*
SUBFAMILY MACROGLOSSINAE		
1. *Cephanodes hylas* 2. *Daphnis nerii* 3. *Macroglossum belis* 4. *Theretra alecto* 5. *Theretra clotho* 6. *Theretra lycetus* 7. *Theretra oldenlandiae* 8. *Theretra castanea* 9. *Pergesa acteus*	1. *Macroglossum gyrans* 2. *Macroglossum particolor* 3. *Macroglossum sitiene*	1. *Nephele hespera* 2. *Neogurelca hyas* 3. *Hippotion boerhaviae* 4. *Theretra nessus*

2. Moth species whose preferred larval food plant is not documented from the study area, and is observed feeding on a single allied species. *Nephele hespera* is the single example in this category.

Among Saturnids, 2 species were generalist and one was an acting specialist, while in Sphingids, 15 species were generalist, 3 were specialists and 5 were acting specialist (Table 2).

Details of individual moth species, along with their larval food plants, have been discussed here. In case of a generalist moth species, the food preferences levels were given as 'Most preferred', 'Preferred' and 'Less preferred'. The plant preference was assessed from the number of caterpillars observed feeding on it. A compiled list of known food plants, recorded plants and new larval food plants along with their moth species is given in Table 3. Some exotic plant species present on the fringes of the study area were seen to be hosts for a few moth species. Additionally, 2 larval food plants, *Arisaema murrayi* and *Pavetta crassicaulis* mentioned in Table 3 were found outside the study area (150-350 km away) on the hills of Mahableshwar and Malshej Ghat. Such plants are marked with an asterisk.

Under each moth species, the following details of the larval food plant has been given:

KFP = Number of Known food plants,
RFP = Number of Recorded food plants,
NR = New records.

Further, under each plant family, details have been given in following format:

- Type of plant, status of plant in the study area,
- Number of caterpillars reared on the plant and
- Preference level of caterpillars *(only for generalist species)*
- Whether the larval food plant recorded during the study was a new record.

FAMILY SATURNIIDAE

As recoded by Hampson (1896), Fellowes-Manson (1920), Beeson (1941), Arora and Gupta (1979), Barlow and D'Abrera (1982), and Chaturvedi (1999), there are 80 known larval food plants for 3 Saturnids, which have been now updated to 90. Details of the larval food plants is mentioned under each species:

1. Indian Moon Moth
Actias selene Hubner 1816

KFP: 27, RFP: 01, NR: 0

Anacardiaceae

1. *Lannea coromandelica* (Houtt.) Merr.: Deciduous tree, Not Common, 05.

2. Tasar Silk Moth
Antheraea paphia Hubner 1818

KFP: 38, RFP: 10, NR: 05

Apocynaceae

1. *Carissa congesta* Wt.: Evergreen shrub, Common, 02, Less preferred, New record.

Bombacaceae

2. *Bombax ceiba* Linn: Deciduous tree, Common, 01, Less Preferred.

Burseraceae

3. *Garuga pinnata* Roxb.: Deciduous tree, Common, 03, Less Preferred.

Combretaceae

4. *Anogeissus latifolia* (DC) Wall. ex Bedd.: Deciduous tree, Not common, 01, Less preferred, New record.

5. *Terminalia catappa* Linn.: Deciduous tree, planted inside the study area, 15, Most Preferred.

6. *Terminalia bellerica* Roxb.: Deciduous tree, Not Common, 05, Preferred.

7. *Terminalia crenulata* Roth.: Deciduous tree, Not common, 03, Preferred, New record.

Euphorbiaceae

8. *Bridelia retusa* (Linn.) Spreng: Deciduous tree, Not common, 02, Less Preferred, New Record.

Rhamnaceae

9. *Zizyphus mauritiana* Lamk.: Evergreen tree, Not common, 12, Most Preferred.

10. *Zizyphus rugosa* Lamk.: Evergreen tree, Not common, 01, Less Preferred, New Record.

3. Atlas Moth *Attacus atlas* Linnaeus 1766

KFP: 19, RFP: 04, NR: 04.

Apocynaceae

1. *Holarrhena antidysenterica*: Deciduous tree, Not common, 03, Preferred, New Record.

Lythraceae

*2. *Lagerstroemia speciosa* Retz.: Deciduous tree, Not found inside the study area, 12, Most Preferred, New Record.

3. *Lagerstroemia lanceolata* Wall: Deciduous tree, Not common, 2, Less Preferred, New Record.

Rubiaceae

4. *Mitragyna parvifolia* (Roxb.) Korth: Evergreen tree, Common, 05, Less Preferred, New Record.

FAMILY SPHINGIDAE

As per Hampson (1896), Scott (1933, 1983), Beeson (1941), Barlow and D'Abrera (1982) and Smetacek (1994) there were 111 known food plants, which have now increased to 144. Details of the larval food plants have been mentioned under each species.

1. Convolvulus Hawkmoth
***Agrius convolvuli* Linnaeus 1758**

KFP: 06, RFP: 05, NR: 05.

Convolvulaceae

1. *Ipomoea sinensis* (Des.) Choicy: Annual climber, Not common, 01, Less preferred, New Record.

*2. *Ipomoea cairica* Linn.: Perennial climber, Not found inside the study area, 05, Most Preferred, New Record.

*3. *Ipomoea carnea* Jacq.: Evergreen shrub, Common outside the study area, 02, Preferred, New Record.

*4. *Ipomoea aquatica* Forsk.: Evergreen runner, Common outside the study area, 02, Less Preferred, New Record.

5. *Ipomoea hederacea* (Jacq.): Annual climber, common, 01, Less preferred, New Record.

2. Dark Death's Head Hawkmoth
***Acherontia lachesis* Fabricius 1798**

KFP: 25, RFP: 07, NR: 06.

Acanthaceae

1. *Barleria prionitis* Linn.: Annual herb, Common, 02, Preferred, New Record.

2. *Carvia callosa*: Annual shrub, Common, 01, Less preferred, New Record.

Boraginaceae

3. *Cordia dichotoma* Forst. f : Deciduous tree, Not common, 01, Less preferred, New Record.

Convolvulaceae

*4. *Ipomoea carnea* Jacq.: Evergreen shrub, Common outside the study area, 01, Less Preferred, New Record.

*5. *Ipomoea aquatica* Forsk.: Evergreen runner, Common outside the study area, 01, Less Preferred, New Record.

Oleaceae

*6. *Nyctanthes arbor-tristis* Linn.: Deciduous shrub, Common outside the study area, 01, Less Preferred.

Solanaceae

7. *Solanum violaceum* Ortega: Deciduous shrub, Not common, 01, Less Preferred, New Record.

3. Dark Psilogramma
***Psilogramma menephron* Cramer 1780**

KFP: 14, RFP: 02, NR: 01.

Bignoniaceae

1. *Oroxylum indicum* (Linn.) Vent.: Deciduous tree, Not common, 01, Less preferred, New Record.

2. **Spathodea campanulata* Beauv.: Evergreen tree, Common outside the study area, 01, Less preferred.

4. Shorthorn Sphinx *Clanis phalaris* Cramer 1777

KFP: 08, RFP: 04, NR: 03.

Fabaceae

1. *Pueraria tuberosa* (Roxb.) DC.: Deciduous climber, Not common, 10, Most Preferred, New Record.

2. *Dalbergia lanceolaria* Linn.f.: Deciduous tree, Not common, 02, Preferred, New Record.

3. *Dalbergia latifolia* Roxb.: Deciduous tree, Not common, 02, Preferred, New Record.

4. *Pterocarpus marsupium* Roxb.: Deciduous tree, Not common, 01, Less Preferred.

5. Dentate Grey Sphinx
***Polyptychus dentatus* Cramer 1777**

KFP: 02, RFP: 02, NR: 01.

Bombacaceae

1. *Bombax ceiba* Linn.: Deciduous tree, Common, 01, Less Preferred, New Record.

Boraginaceae

1. *Cordia dichotoma* Forst. F: Deciduous tree, Not common, 08, Most preferred.

6. Spotted Marumba *Marumba dyras* Walker 1856

KFP: 10, RFP: 5, NR: 03.

Bombacaceae

1. *Bombax ceiba* Linn.: Deciduous tree, Common, 10, Most Preferred.

Euphorbiaceae

2. *Bridelia retusa* (Linn.) Spreng.: Deciduous tree, Not common, 02, Less Preferred, New Record.

Sterculiaceae

3. *Firmiana colorata* (Roxb.) R.Br.: Deciduous tree, Not common, 50, Most Preferred, New Record.

4. *Helicteres isora* Linn.: Deciduous shrub, Very common, 10, Most Preferred.

Tiliaceae

5. *Grewia inequalis* Bl.: Deciduous tree, Common, 04, Less Preferred, New Record.

7. Brown Tip Marumba
***Marumba indicus* Walker 1856**

KFP: 05, RFP: 01, NR: 01.

Sterculiaceae

1. *Firmiana colorata* (Roxb.) R. Br.: Deciduous tree, Not common, 25 (caterpillars reared at a time from an egg clutch), New Record.

8. Coffee Bee Hawkmoth
***Cephanodes hylas hylas* Linnaeus 1771**

KFP: 13, RFP: 08, NR: 05.

Rubiaceae

1. *Catunaregam spinarum* (L.) Tiruveng:

Evergreen shrub, Not common, 02, Less Preferred.

2. *Gardenia lucida* Roxb.: Evergreen tree , Not common, 03, Most Preferred, New Record.

3. **Gardenia florida* Linn.: Evergreen shrub, Common outside the study area, 05, Most Preferred.

4. *Haldina cordifolia* (Roxb.) Ridsdale: Evergreen tree, Not common, 02, Less Preferred.

5. *Hymenodictyon orixense* (Roxb.) Mabb.: Evergreen tree, Not common, 03, Most Preferred, New Record.

6. *Mitragyna parvifolia* (Roxb.) Korth.: Evergreen tree, Common, 03, Most Preferred, New Record.

7. **Pavetta crassicaulis* Bremek.: Deciduous tree, Not common, 01, Less Preferred, New Record.

8. *Pavetta siphonantha* Dalz.: Deciduous tree, Not common, 01, Less Preferred.

9. Oleander Hawkmoth
***Daphnis nerii* Linnaeus 1758**
KFP: 05, RFP: 02, NR: 01.

Apocynaceae

*1. *Alstonia scholaris* R.Br.: Evergreen tree, Not found in the study area, 01, Less preferred, New Record.

2. *Tabernaemontana coronaria* Wild.: Perennial shrub, Not found inside the study area, 06, Most Preferred.

10. Carissa Hawkmoth
***Nephele hespera* Fabricius 1775**
KFP: 01, RFP: 01, NR: 01.

Apocynaceae

1. *Carissa congesta* Wt.: Evergreen shrub, Common, 16, New Record.

11. Turntail Hawkmoth
***Neogurelca hyas* Walker 1856**
KFP: 03, RFP: 01, NR: 0.

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 05.

12. Little Hummingbird Moth
***Macroglossum gyrans* Walker 1856**
KFP: 01, RFP: 01, NR: 0.

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 31.

13. Hourglass Hummingbird Moth
***Macroglossum particolor* Rothschild & Jordan 1903**
KFP: 01, RFP: 01, NR: 0.

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 02.

14. Large Hummingbird Moth
***Macroglossum belis* Linnaeus 1758**
KFP: 04, RFP: 02, NR: 02.

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 04, Most preferred, New Record.

2. *Spermadictyon suaveolens* Roxb.: Evergreen tree, Not found in the study area, 03, Less preferred, New Record.

15. Yellow Banded Hummingbird Moth
***Macroglossum sitiene* Walker 1856**
KFP: 01, RFP: 01, NR: 01.

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 02.

16. Hogweed Hawkmoth
***Hippotion boerhaviae* Fabricius 1775**
KFP: 06, RFP: 01, NR: 0.

Nyctaginaceae

1. *Boerhavia diffusa* Linn.: Annual herb, Not common, 01.

17. Large Yam Hawkmoth
***Theretra nessus* Drury 1773**
KFP: 05, RFP: 01, NR: 01.

Dioscoreaceae

1. *Dioscorea hispida* Dennst.: Annual herb, Not common, 01, New Record.

18. Grapevine Black Hawkmoth
***Theretra clotho clotho* Drury 1773**
KFP: 05, RFP: 05, NR: 05.

Araceae

1. *Amorphophallus commutatus* (Schott.) Engler: Annual herb, Common, 01, Less Preferred, New Record.

Leeaceae

2. *Leea asiatica* (Linn.) Ridsdale: Annual herb, Very common, 02, Preferred, New Record.

Vitaceae

3. *Ampelocissus latifolia* (Roxb.) Planch.: Annual climber, Very common, 05, Most preferred, New Record.

4. *Cayratia triflora* (Linn.) Domin: Annual climber, Not common, 01, Less preferred, New Record.

5. *Cissus elongata* Roxb.: Annual climber, Not common, 02, Preferred, New Record.

19. Levant Hawkmoth
***Theretra alecto alecto* Linnaeus 1758**
KFP: 06, RFP: 02, NR: 02.

Table 3: List of Larval Food Plants

Moth Species	Known Food Plants (Food plants known from the study area are given in bold type)	Food Plants Recorded (new records are given in bold type)
Family Saturniidae		
1. *Actias selene*	1. *Andromeda ovalifolia*	1. ***Lannea coromandelica***
	2. *Azadirachta indica*	
	3. *Betula alnoides*	
	4. *Carpinus bimana*	
	5. *Coriaria nepalensis*	
	6. *Corylus columa*	
	7. *Crataegus* sp.	
	8. *Hibiscus* sp.	
	9. *Juglans regia*	
	10. ***Lagerstroemia lanceolata***	
	11. ***Lannea coromandelica***	
	12. *Lawsonia alba*	
	13. *Ligustrum robustum*	
	14. *Moringa pterygosperma*	
	15. *Prunus amygdalus*	
	16. *Prunus cerasus*	
	17. *Prunus domestica*	
	18. *Prunus padus*	
	19. *Prunus puddum*	
	20. *Pyrus communis*	
	21. *Pyrus malus*	
	22. *Rhamnus frangula*	
	23. *Salix babylonica*	
	24. *Salix elegans*	
	25. *Terminalia paniculata*	
	26. *Zanthoxylum acanthopium*	
	27. *Zanthoxylum alatum*	
2. *Antheraea paphia*	1. ***Bassia latifolia***	1. ***Anogeissus latifolia***
	2. *Bauhinia variegata*	2. ***Bridelia retusa***
	3. ***Bombax ceiba***	3. *Bombax ceiba*
	4. *Bombax heptaphyllum*	4. ***Carissa congesta***
	5. *Canthium dicoccum*	5. *Garuga pinnata*
	6. ***Careya arborea***	6. *Terminalia bellerica*
	7. *Careya sphaerica*	7. *Terminalia catappa*
	8. *Carpinus betulus*	8. ***Terminalia crenulata***
	9. *Carissa carandas*	9. *Zizyphus mauritiana*
	10. *Chloroxylon swietenia*	10. ***Zizyphus rugosa***
	11. *Cipadessa fruticosa*	
	12. *Dalbergia* sp.	
	13. *Dodonaea viscosa*	
	14. *Eucalyptus* sp.	
	15. *Ficus benjamina*	
	16. ***Ficus religiosa***	
	17. *Ficus retusa*	
	18. *Garuga pinnata*	
	19. *Lagerstroemia indica*	
	20. ***Lagerstroemia parviflora***	
	21. *Lagerstroemia pentaptera*	
	22. ***Pongamia pinnata***	
	23. *Pongamia tomentosa*	
	24. *Prunus domestica*	
	25. *Quercus* sp.	
	26. *Rhizophora calceolaris*	
	27. ***Ricinus communis***	
	28. *Shorea robusta*	
	29. *Shorea talura*	
	30. *Syzygium cumini*	
	31. ***Tectona grandis***	
	32. ***Terminalia catappa***	
	33. *Terminalia alata*	
	34. *Terminalia arjuna*	
	35. ***Terminalia bellerica***	

Table 3: List of Larval Food Plants (contd.)

Moth Species	Known Food Plants (Food plants known from the study area are given in bold type)	Food Plants Recorded (new records are given in bold type)
	36. *Terminalia paniculata*	
	37. *Terminalia tomentosa*	
	38. ***Zizyphus mauritiana***	
2. *Attacus atlas*	1. *Ardisia* sp.	1. ***Lagerstroemia speciosa****
	2. *Berberis* sp.	2. ***Lagerstroemia lancelota***
	3. *Bradleia ovata*	3. ***Mitragyna parvifolia***
	4. *Carpinus betulus*	4. ***Holarrhena antidysenterica***
	5. *Clerodendrum infortunatum*	
	6. ***Dillenia pentagyna***	
	7. *Falconesia insignis*	
	8. *Lagerstroemia indica*	
	9. *Nalbeli* sp.	
	10. *Nauclea rotundifolia*	
	11. *Ocimum* sp.	
	12. *Phyllanthus emblica*	
	13. *Pyrus malus*	
	14. *Salix babylonia*	
	15. *Salix elegans*	
	16. *Sarcostemma brevistigma*	
	17. *Schleichera oleosa*	
	18. *Teucrium macrostachyum*	
	19. ***Vangueria spinosa***	
Family Sphingidae		
1. *Agrius convolvuli*	1. *Arachis hypogea*	1. ***Ipomoea sinensis***
	2. *Convolvulus* spp.	2. ***Ipomoea cairica****
	3. *Dolichos lablab*	3. ***Ipomoea carnea****
	4. *Helianthus* sp.	4. ***Ipomoea aquatica****
	5. *Ipomoea* sp.	5. ***Ipomoea hederacea***
	6. *Phaseolus* sp.	
2. *Acherontia lachesis*	1. *Anisomeles ovata*	1. ***Barleria prionitis***
	2. *Antidesma* sp.	2. ***Carvia callosa***
	3. *Callicarpa arborea*	3. ***Cordia dichotoma***
	4. *Carapa arborea*	4. ***Ipomoea carnea****
	5. *Carapa macrophylla*	5. ***Ipomoea aquatica****
	6. *Clerodendrum* sp.	6. *Nyctanthes arbor-tristis**
	7. ***Colebrookia oppositifolia***	7. ***Solanum violaceum***
	8. *Coleus* sp.	
	9. *Datura* sp.	
	10. *Erythrina lithosperma*	
	11. ***Erythrina variegata***	
	12. *Ipomoea* sp.	
	13. *Jasminum arborescens*	
	14. *Lablab purpurens*	
	15. ***Lantana camara***	
	16. *Mussaenda frondosa*	
	17. *Nicotiana tabacum*	
	18. ***Nyctanthes arbor-tristis****	
	19. *Solanum* sp.	
	20. *Spathodea campanulata*	
	21. ***Stachytarpheta indica***	
	22. *Stereospermum* sp.	
	23. *Tectona grandiflora*	
	24. ***Tectona grandis***	
	25. *Vitex negundo*	
3. *Psilogramma menephron*	1. *Aporosa villosa*	1. ***Oroxylum indicum***
	2. *Callicarpa arborea*	2. *Spathodea campanulata**

Table 3: List of Larval Food Plants (contd.)

Moth Species	Known Food Plants (Food plants known from the study area are given in bold type)	Food Plants Recorded (new records are given in bold type)
	3. *Clerodendrum infortunatum* 4. ***Gmelina arborea*** 5. *Heterophragma adenophyllum* 6. *Jasminum arborescens* 7. *Ligustrum robustum* 8. *Meliosma fordii* 9. *Nyctanthes arbor-tristis* 10. *Olea viaticum* 11. ***Spathodea campanulata*** * 12. ***Stereospermum chelenoides*** 13. ***Tectona grandis*** 14. *Vitex negundo*	
4. *Clanis phalaris*	1. ***Butea monosperma*** 2. ***Cassia fistula*** 3. ***Dalbergia volubilis*** 4. *Milletia atropurpurea* 5. ***Mucuna pruriens*** 6. ***Pongamia pinnata*** 7. ***Pterocarpus marsupium*** 8. *Xylia xylocarpa*	1. ***Dalbergia lanceolaria*** 2. ***Dalbergia latifolia*** 3. *Pterocarpus marsupium* 4. ***Pueraria tuberosa***
5. *Polyptychus dentatus*	1. ***Cordia dichotoma*** 2. *Ehretia* sp.	1. ***Bombax ceiba*** 2. *Cordia dichotoma*
6. *Marumba dyras*	1. ***Bombax ceiba*** 2. *Bridelia* sp.	1. *Bombax ceiba* 2. ***Bridelia retusa***
	3. *Cordia rothi* 4. *Ehretia laevis* 5. ***Grewia microcos*** 6. ***Helicteres isora*** 7. ***Kydia calycina*** 8. ***Sapindus trifoliatus*** 9. ***Schleichera trijuga*** 10. ***Sterculia villosa***	3. ***Firmiana colorata*** 4. ***Grewia inequalis*** 5. *Helicteres isora*
7. *Marumba indicus*	1. ***Bombax ceiba*** 2. ***Grewia inequalis*** 3. ***Helicteres isora*** 4. ***Sterculia urens*** 5. *Sterculia villosa*	1. ***Firmiana colorata***
8. *Cephanodes hylas*	1. ***Catunaregam spinarum*** 2. *Coffea benghalensis* 3. ***Gardenia florida*** * 4. ***Haldina cordifolia*** 5. ***Hymenodictyon obovatum*** 6. *Hymenodictyon excelsum* 7. ***Ixora brachiata*** 8. *Pavetta indica* 9. *Stephegyne diversifolia* 10. ***Stephegyne parvifolia*** 11. ***Tectona grandis*** 12. *Wendlandia* spp. 13. *Xylia xylocarpa*	1. *Catunaregam spinarum* 2. *Gardenia florida** 3. ***Gardenia lucida*** 4. *Haldina cordifolia* 5. ***Hymenodictyon orixense*** 6. ***Mitragyna parvifolia*** 7. ***Pavetta siphonantha*** 8. ***Pavetta crassicaulis*** *

Table 3: List of Larval Food Plants (contd.)

Moth Species	Known Food Plants (Food plants known from the study area are given in bold type)	Food Plants Recorded (new records are given in bold type)
9. *Daphnis nerii*	1. *Ervatamia alternifolia* 2. ***Holarrhena antidysenterica*** 3. *Nerium odorum* 4. ***Tabernaemontana coronaria*** 5. *Vinca* sp.	1. ***Alstonia scholaris*** 2. *Tabernaemontana coronaria**
10. *Nephele hespera*	1. *Carissa carandas*	1. ***Carissa congesta***
11. *Neogurelca hyas*	1. *Morinda citrifolia* 2. *Morinda tinctoria* 3. *Paederia foetida*	1. *Morinda tinctoria* var. *tomentosa*
12. *Macroglossum gyrans*	1. ***Morinda tinctoria***	1. *Morinda tinctoria* var. *tomentosa*
13. *Macroglossum particolor*	1. *Morinda citrifolia*	1. ***Morinda tinctoria* var. *tomentosa***
14. *Macroglossum belis*	1. *Hamiltonia suaveolens* 2. *Morinda* sp. 3. *Saprosma indicum* 4. ***Strychnos nux-vomica***	1. ***Morinda tinctoria* var. *tomentosa*** 2. ***Spermadictyon suaveolens***
15. *Macroglossum sitiene*	1. *Morinda umbellata*	1. ***Morinda tinctoria* var. *tomentosa***
16. *Hippotion boerhavia*	1. ***Impatiens* spp.** 2. *Spermacoce hispida* 3. *Spermacoce stricta* 4. ***Boerhavia diffusa*** 5. *Boerhavia repens* 6. *Glossostigma spathulatum*	1. *Boerhavia diffusa*
17. *Theretra nessus*	1. *Amorphophallus* sp. 2. *Barringtonia* sp. 3. *Convolvulus* sp. 4. *Dioscorea* sp. 5. ***Pongamia pinnata***	1. ***Dioscorea hispida***
18. *Theretra clotho*	1. ***Amorphophallus* sp.** 2. *Begonia* sp. 3. ***Dillenia* sp.** 4. *Fuchsia* sp. 5. ***Vitis* sp.**	1. ***Amorphophallus commutatus*** 2. ***Ampelocissus latifolia*** 3. ***Cayratia triflora*** 4. ***Cissus elongata*** 5. ***Leea asiatica***
19. *Theretra alecto*	1. *Dillenia indica* 2. ***Leea* sp.** 3. *Psychotria* sp. 4. *Rubia cordifolia* 5. *Shorea robusta* 6. ***Vitis trifolia***	1. ***Ampelocissus latifolia*** 2. ***Morinda tinctoria* var. *tomentosa***
20. *Theretra lycetus*	1. *Arum* sp. 2. ***Dillenia pentagyna*** 3. *Leea sambucina* 4. ***Vitis* sp.**	1. ***Leea asiatica*** 2. ***Leea macrophylla***
21. *Theretra oldenlandiae*	1. *Arisaema* sp.	1. ***Ampelocissus latifolia***

Table 3: List of Larval Food Plants (contd.)

Moth Species	Known Food Plants (Food plants known from the study area are given in bold type)	Food Plants Recorded (new records are given in bold type)
	2. ***Caryea arborea*** 3. *Caladium bicolor* 4. *Colocasia fallax* 5. ***Corchorus capsularis*** 6. *Cryptocoryne* sp. 7. ***Impatiens* sp.** 8. *Ipomoea batatas* 9. ***Jussiaea suffruticosa*** 10. ***Oldenlandia corymbosa*** 11. ***Vitis* sp.**	2. ***Impatiens balsamina***
22. *Theretra castanea*	1. *Ariopsis peltata*	1. ***Amorphophallus commutatus***
	2. *Arisaema* sp. 3. *Knoxia mollis* 4. *Impatiens cuspidata*	2. ***Arisaema murrayi****
23. *Pergesa acteus*	1. ***Amorphophallus* sp.** 2. *Arisaema* sp. 3. *Begonia* sp. 4. *Caladium bicolor* 5. ***Colocasia* sp.** 6. ***Commelina bengalensis*** 7. ***Vitis* sp.**	1. ***Amorphophallus commutatus*** 2. ***Leea asiatica***

* : Recorded outside study area

Rubiaceae

1. *Morinda tinctoria* var. *tomentosa* Roxb.: Evergreen tree, Common, 02. preferred, New Record.

Vitaceae

2. *Ampelocissus latifolia* (Roxb.) Planch.: Annual climber, Very common, 02, New Record.

20. Golden Striped Sphinx

***Theretra lycetus* Cramer 1775**

KFP: 04, RFP: 02, NR: 02.

Leeaceae

1. *Leea asiatica* (Linn.) Ridsdale: Annual herb, Very common, 14, Most Preferred, New Record.

2. *Leea macrophylla* Roxb. ex Hornem: Annual herb, Not common, 04, Preferred, New Record.

21. Silver Striped Hawkmoth

***Theretra oldenlandiae* Fabricius 1775**

KFP: 11, RFP: 02, NR: 02.

Balsaminaceae

1. *Impatiens balsamina* Linn.: Annual herb, Common, 01, Less Preferred, New Record.

Vitaceae

2. *Ampelocissus latifolia* (Roxb.) Planch.: Annual climber, Very common, 02, Preferred, New Record.

22. Copper Hawkmoth

***Theretra castanea* Moore 1872**

KFP: 04, RFP: 02, NR: 02.

Araceae

1. *Arisaema murrayi* Hook: Annual herb, Not found in the study area, 16, Most preferred, New Record.

2. *Amorphophallus commutatus* (Schott.) Engler: Annual herb, Common, 01, Preferred, New Record.

23. Little Yam Hawkmoth

***Pergesa acteus* Cramer 1779**

KFP: 07, RFP: 02, NR: 02

Araceae

1. *Amorphophallus commutatus* (Schott.) Engler: Annual herb, Common, 04, Most preferred, New Record.

Leeaceae

2. *Leea asiatica* (Linn.) Ridsdale: Annual herb, Very common, 01, Less Preferred, New Record.

The larval food plants were recorded from the study area as well as from other areas (Table 3). For Family Saturniidae, of the 80 known food plants, 17 are found in the study area, of which we recorded only 5 along with 10 new larval food plants. For Family Sphingidae, of the 111 known food plants, 49 are found in the study area, of which we recorded 11 along with 33 new larval food plants. The ratio of known to new food plants for each family is 80:10 for Saturnids and 111:33 for Sphingids.

ABUNDANCE OF LARVAL FOOD PLANTS

As the study area has predominantly deciduous vegetation, analysis was carried out in order to assess the food availability in different seasons. The vegetation analysis of the recorded larval food plants was conducted in two seasons, Monsoon (July) and Non-Monsoon (March) so that both seasonal and perennial food plants were covered.

The monsoon survey showed that most of the food plants were seasonal climbers and shrubs. *Leea asiatica*, *L. macrophylla*, *Amorphophallus commutatus*, *Ampelocissus latifolia* and *Pueraria tuberosa* were available during the monsoon in the study area. These perennial plants had very short life cycles that synchronized with the end of the monsoon. The abundance of the seasonal plants exceeded that of the perennial food plants in the study area. All the recorded larval food plants could not be covered in the vegetation analysis, as they did not fall within the range of the quadrats laid out. Altogether, 22 larval food plants were recorded, of which 6 were deciduous, 10 were evergreen and 6 were seasonal. As per Fig. 3, it was observed that during monsoon, the herb *Leea asiatica* was most abundant, followed by a shrub *Helicteres isora,* climber *Ampelocissus latifolia* and herb *Amorphophallus commutatus*. Except *Helicteres isora,* the others were seasonal plants. Eleven larval food plants, which were poorly represented in the survey, were listed as 'Others' in Fig. 3. These included *Hymenodictyon orixense*, *Terminalia crenulata*, *Haldina cordifolia*, *Leea macrophylla*, *Pueraria tuberosa*, *Pavetta siphonantha*, *Zizyphus mauritiana*, *Mitragyna parvifolia*, *Gardenia lucida*, *Cordia dichotoma* and *Zizyphus rugosa*.

The survey of food plants in the non-monsoon season showed low diversity. It was observed that most of the food plants recorded were evergreen with mature leaves, except *Morinda tinctoria* var. *tomentosa* and *Carissa congesta* that had tender leaves, which was foraged by the caterpillars. The survey documented 6 species of larval food plants (see Fig. 4), which were solely foraged by Sphingids. These were all evergreen trees, except for the shrub *Helicteres isora*, which was deciduous. Of the 6 species, 3 were dominant, contributing 95% of the total larval food plants. The most dominant was *Helicteres isora,* followed by the evergreen *Carissa congesta* and *Morinda tinctoria*. The other evergreen plants, *Hymenodictyon orixense*, and *Haldina cordifolia* and *Gardenia lucida* among 'Others' in Fig. 4 constituted the remainder.

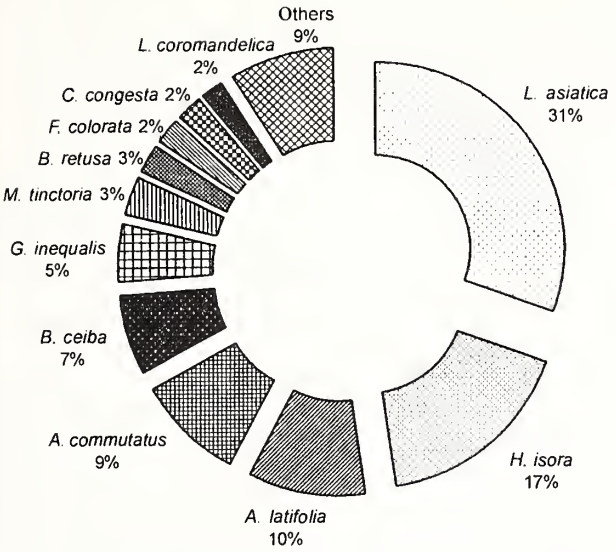

Fig. 3: Abundance of Larval Food Plants (Wet Season)

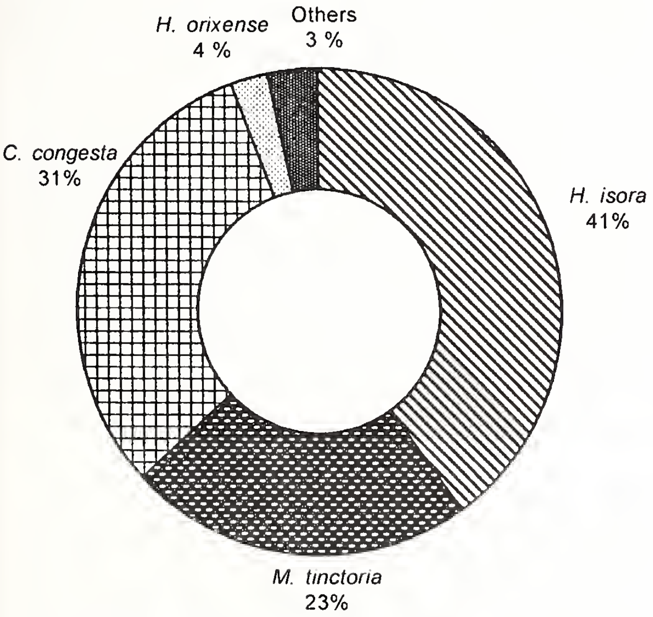

Fig. 4: Abundance of Larval Food Plants (Dry Season)

DISCUSSION

Seasonal occurrence of larval food plants was found to determine the moth species feeding on the plants. Since Sphingids feed on seasonal as well as perennial plants, they were found throughout the year, while Saturnids, which mainly feed on deciduous trees in the larval stage suffered a setback. Family Sphingidae utilizes a variety of larval food plants, ranging from climbers to trees, whereas Saturniidae exclusively preferred trees. The variation observed for Sphingidae was not only in the diversity, but also in the abundance of food plants.

The study supports the views of Speight and Wain House (1989), who stated that food plants that are abundant and widely distributed are host to more insect species than those with restricted distribution. For Sphingidae, the plant family Rubiaceae, which supports maximum moth species i.e. 8., being common and perennial, was available throughout the year, especially for *Macroglossum gyrans*, which was also found round the year.

The finding also reflected the views of Jermy (1984), who stated that insect diversity could be broadly predicted from the abundance of a particular plant species. This association clearly proves that insects and plants have co-evolved. In the study area, 33 new larval food plants supported 20 species of Sphingid Hawkmoths, showing clearly the relation between moth diversity and abundance of the food plants. With the new and present records the number of larval food plants for Family Saturniidae has increased from 80 to 90 and for Family Sphingidae from 111 to 144.

The study also supports Scott (1933) who theorised that the selection of certain food plants by moths appears to be not very reliable. Though the occurrence of moth species is solely dependent on the availability of food plants, the range of any species of hawkmoth (e.g. *Marumba dyras*) is by no means coincidental with that of its food plants, while some common species (e.g. *Macroglossum belis*) may be found where their food plants are available, others (e.g. *Pergesa acteus*) are found only in very restricted areas, though their food plant covers a wide range. One species was common (e.g. *Theretra clotho*) and widespread; while another closely allied (e.g. *Theretra alecto*) species feeding on the same plant was rare and restricted.

In generalist moth species, it was observed that while a few species were selective about their larval food plants, some showed 'acting specialist' behaviour. In Family Saturniidae, *Actias selene* was the acting specialist because it preferred *Lannea coromandelica* over *Lagerstroemia lanceolata*, a known food plant from the study area, while *Nephele hespera* from Family Sphingidae known to prefer *Carissa carandas*, which was restricted to the southern part of the country, preferred *Carissa congesta*, an allied plant species in the study area. In generalist species, moths preferred new larval food plants over the known e.g. *Marumba indicus*, which had 4 known larval food plants from the study area, preferred a new larval food plant. Also, *Theretra clotho* ignored its only known larval food plant for 5 new larval food plants, while *Neogurelca hyas* preferred one to its 3 known larval food plants. Since the known larval food plants were compiled from different parts of the country, it could be concluded that geographical location and climatic variation possibly influences larval food plant selection of Saturnids and Sphingids.

Lastly as per Scott (1933), the specialist and acting specialist species, such as *Nephele hespera* and *Macroglossum gyrans*, would be treated as indicator species, which exclusively preferred single plant species i.e. *Carissa congesta* and *Morinda tinctoria* var. *tomentosa* and could be used in habitat monitoring programmes of the study area.

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NEW DESCRIPTIONS

A NEW SPECIES OF WOLF SPIDER (ARANEAE: LYCOSIDAE) FROM CROP FIELDS OF THE SUNDARBAN ESTUARY, WEST BENGAL, INDIA[1]

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One new species of wolf spider *Arctosa sandeshkhaliensis* sp. nov. from the crop fields of Sundarban estuary has been described and illustrated.

Key words: Spiders, Lycosidae, *Arctosa sandeshkhaliensis* sp. nov., Sundarban

INTRODUCTION

The unique and fascinating Sundarban is the largest natural mangrove block in the world. Various workers, including Tikader and Malhotra (1980), Majumder and Tikader (1991), Biswas and Biswas (1992) have studied the taxonomy of spiders from Sundarban. Tikader and Malhotra (1980) described one new species and reported four species of wolf spider from the Sundarban estuarine region. Majumder and Tikader (1991) described one and reported 3 species of sac spiders from this area. Biswas and Biswas (1992) reported only one species of wolf spider from Sundarban area. In the present study, a new species *Arctosa sandeshkhaliensis* has been identified. The types of the new species are deposited in the National Collection of Zoological Survey of India, Kolkata.

MATERIAL AND METHODS

Spiders were collected from different crop fields of the Sundarban estuarine ecosystem, namely Hasnabad, Hengalgunj, Sandeshkhali and Gosaba. The spiders were collected by hand and placed in vials which were brought to the laboratory. The specimens were transferred to 70% alcohol in a petri dish for 6-12 hours for relaxation of body parts. All specimens were preserved in 70% alcohol (single specimen in each vial) for further studies as in Tikader (1987).

Arctosa sandeshkhaliensis sp. nov.
(Figs 1-6)

General Description: **Holotype**: FEMALE: Cephalothorax and legs yellowish-brown, abdomen blackish (in preserved specimens).

Measurements (in mm): Total length 6.30, carapace length 3.50, width 3.20, abdominal length 2.80, width 2.50, legs as in Table 1.

Cephalothorax: Carapace slightly longer than wide, narrowed anteriorly and wider at the middle; cephalic region slightly raised. Anterior margin of the cephalothorax straight with the anterolateral corner raised and conical with a few long yellowish-brown hairs. Thoracic region provided with a deeply distinct longitudinal fovea. Eyes pearly white encircled by black patches. Anterior row of eyes straight, smaller in structure. The eyes of the second and third rows similar in structure and larger than those of the first row (Fig. 1). Ocular quadrate longer than wide; wider posteriorly and narrowed anteriorly. Sternum oval, pointed behind. Chelicerae longer than wide, inner margin with 4 teeth, outer margin with 2 teeth (Fig. 2). Maxillae longer than wide, reddish-brown, anterior end wider and scopulated, posterior end narrowed, labium wider than long (Fig. 3). Legs long, not so strong, covered with hair and spines. Tibia with ventral spines; tarsal scopulae distinct. Leg formula 4 2 1 3.

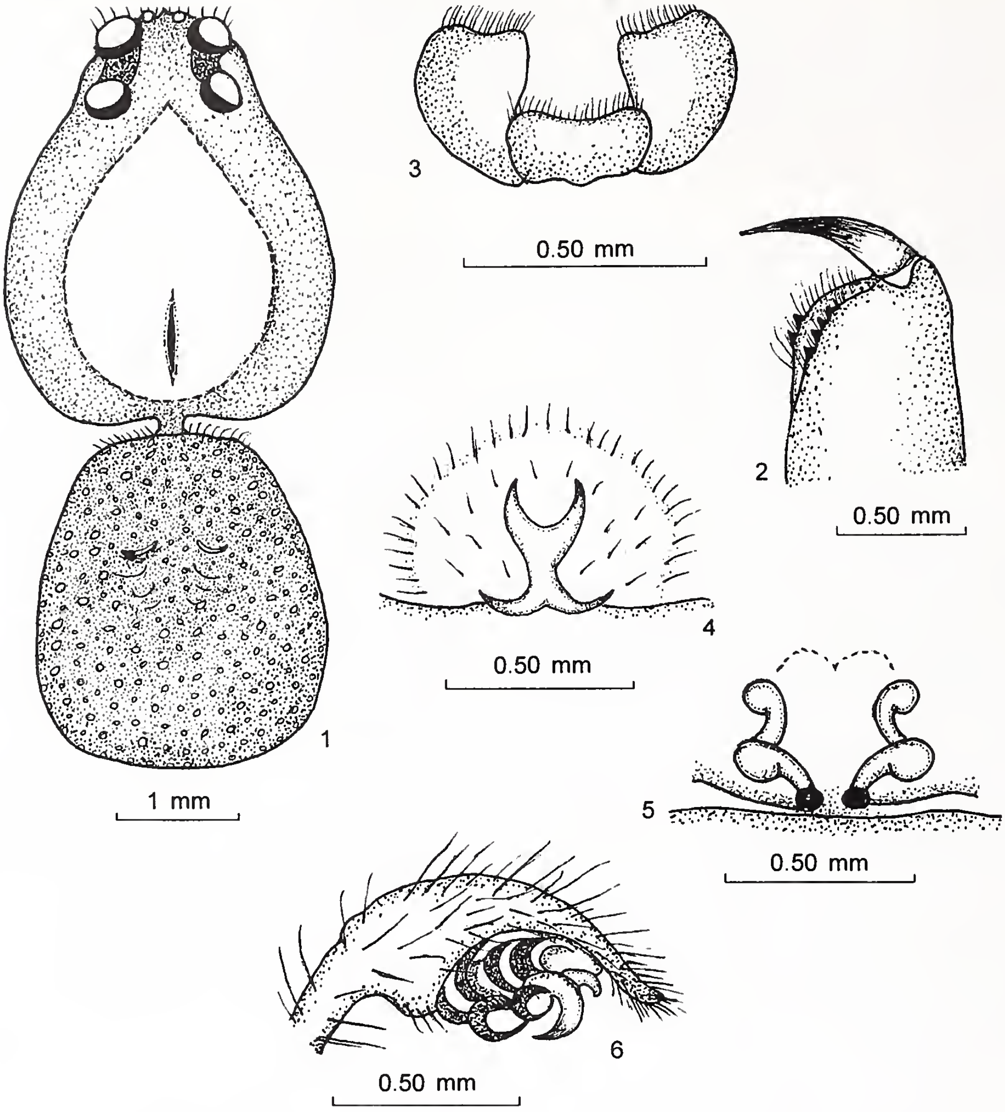
Abdomen: Longer than wide, oval, dorsum covered with fine pubescence, blunt posteriorly. Venter yellow with brown longitudinal band. Epigyne bifurcated into anterior and posterior plates (Fig. 4). Internal genitalia provided with coiled copulatory sac and copulatory openings divided into two parts (Fig. 5).

Allotype: MALE: Similar to female except that the male palp is without retrolateral apophysis, cymbium long and semilunar in shape with narrower anteriorly without basal spur, tegulum rounded and convex with flower-like regular apophysis, embolus narrowed and elongated, abdomen with whitish patches on dorsum (Fig. 6).

Measurements (in mm): Total length 5.60, Carapace length 3.40, width 2.20, abdomen length 3.15, width 2.10, legs as in Table 2, palp as in Table 3.

Material examined: **Holotype**: ♀, Allotype: 1♂, in 70% Alcohol in separate vials, genitalia in microvial with holotype. Coll. S.C. Majumder, 16 & 17.i.1994, N.C., ZSI (H.Q.), Regn. No. 5472/18 & 5473/18.

Type Locality: Durgamandap, Sandeshkhali, North 24 Parganas, West Bengal.



Figs 1-6: *Arctosa sandeshkhaliensis* sp. nov., 1. Dorsal view of female, legs omitted, 2. Chelicera showing arrangement of teeth, 3. Maxillae and labium, ventral aspect, 4. Epigyne, ventral aspect, 5. Internal genitalia, dorsal aspect, 6. Male palp, lateral aspect

Table 1: Measurements (in mm) of leg segments of *Arctosa sandeshkhaliensis* sp. nov. (Female)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	2.10/2.10	2.80/2.80	2.00/2.00	1.10/1.10	8.00
II	2.80/2.80	3.10/3.10	1.20/1.20	1.15/1.15	8.25
III	1.80/1.80	2.50/2.50	1.90/1.90	1.05/1.05	7.25
IV	3.10/3.10	3.50/3.50	2.30/2.30	1.30/1.30	10.20

Distribution: Sundarban areas (Sandeshkhali, North 24 Parganas), West Bengal, India.

Discussion: This species resembles *Arctosa khudiensis* Tikader & Malhotra in general appearance, but differs from it in the following particulars.

1. Cephalothorax not parallel sided, wider at the middle, abdomen blunt posteriorly, whereas in *A. khudiensis* Tikader and Malhotra cephalothorax more or less parallel sided and not wider at the middle, abdomen not blunt posteriorly.

2. The eyes of the second row similar in structure with those of the third row, whereas in *A. khudiensis* eyes of the second row larger than those of the third row.

3. Epigyne structurally different.

Table 2: Measurements (in mm) of leg segments of *Arctosa sandeshkhaliensis* sp. nov. (Male)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	2.20/2.20	2.40/2.40	2.05/2.05	1.05/1.05	7.70
II	2.40/2.40	2.60/2.60	2.10/2.10	1.05/1.05	8.15
III	2.10/2.10	2.30/2.30	2.05/2.05	1.05/1.05	7.5
IV	2.60/2.60	2.90/2.90	2.30/2.30	1.10/1.10	8.90

Table 3: Measurements (in mm) of male palp of *Arctosa sandeshkhaliensis* sp. nov.

Femur	Patella	Cymbium & tegulum	Embolus	Total
1.70/1.70	1.20/1.20	2.50/2.50	1.50/1.50	6.90/6.90

Etymology: The species is named after the type locality Sandeshkhali.

ACKNOWLEDGEMENTS

I thank Dr. J.R.B. Alfred, Director, Zoological Survey of India, Kolkata and Shri K.N. Reddy, Officer-in-charge, Sundarban Field Research Station, Canning, West Bengal for kind permission to carry out the work and also Dr. B.K. Biswas Scientist SE & Officer-in-charge, Arachnida Station, Zoological Survey of India, Kolkata for confirming the new species.

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NEW ORB-WEAVING SPIDERS OF THE GENUS *CYRTOPHORA* SIMON (ARANEAE: ARANEIDAE) FROM BANGLADESH[1]

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Two new species of orb-weaving spiders of the Genus *Cyrtophora* Simon, *C. nareshi* and *C. lahirii* are described and illustrated. Another, *C. cicatrosa* (Stoliczka) is reported as a new record for the country. A key to the species is also given.

Key words: Spider, new species, new record, *Cyrtophora*, Araneae, Araneidae, Bangladesh

INTRODUCTION

Spiders of the Family Araneidae (=Argiopidae) are poorly known in Bangladesh, though Chowdhury and Nagari (1981), Chowdhury and Pal (1984), Biswas *et al.* (1993), Okuma *et al.* (1993), Begum and Biswas (1997), and Biswas and Raychaudhuri (1998) have made some valuable contributions. Spider fauna of neighbouring countries, like Burma (Thorell 1895), India (Pocock 1900; Tikader 1970, 1982; Tikader and Bal 1981; Tikader and Biswas 1981; Saha *et al.* 1995; Biswas *et al.* 1997) and Pakistan (Dyal 1935) are well documented.

The Genus *Cyrtophora* Simon, recorded since 1988 from Bangladesh, is composed of three species of which two *C. lahirii* and *C. nareshi* are new to science, while *C. cicatrosa* (Stoliczka) was hitherto unknown from Bangladesh.

The types are at present in the collection of the Department of Zoology, Government P.C. College, Bagerhat, Bangladesh and will be deposited in the Museum of the Department of Zoology, University of Dhaka, Bangladesh.

MATERIAL AND METHODS

Collection of spider specimens was done following Kaston (1972), Mackie (1978) and Tikader (1987). The collected materials were studied using a Stereozoom Binocular Microscope (Model, Zeiss-SV8) and all the measurements (in mm) were taken with an eyepiece.

The species were identified following Tikader (1982, 1987), Chen and Zhang (1989), Zhao (1993), Yaginuma (1986), Davies (1988) and Yin *et al.* (1997) and confirmed by the Zoological Survey of India, Kolkata.

Genus: ***Cyrtophora* Simon 1864**

1864. *Cyrtophora* Simon, *Hist. Nat. des Araign.*, *1*: 261.

1890. *Euetria*: Thorell, *Annali. Mus. civ. Genova*, *28*: 109.

1921. *Cyrtophora*: Gravely, *Rec. Indian Mus.*, *22(4)*: 413.

1962. *Cyrtophora*: Tikader, *J. Linn. Soc.*, *44(300)*: 561.

1993. *Cyrtophora*: Okuma *et al.*, *Illust. Mongr. Rice-field spiders, Bangladesh*: 29.

1997. *Cyrtophora*: Platnick, *Advances in Spider Taxonomy* (1992-95): 498.

KEY TO THE SPECIES

1. Abdomen anteriorly with 4 conical humps, posteriorly sloped and rectangularly produced (Fig. 1); sternum with long, slender, white band (Fig. 4); epigyne and internal genitalia as in Figs 5 and 6 .... *cicatrosa*

— Abdomen without above characteristics; sternum with V and U-shaped area 2

2. Abdomen parallel-sided (Fig. 7); cephalic region never raised or produced (Fig. 7); sternum broadly triangular, medially with a U-shaped longitudinal reticulate area (Fig. 10); inner and outer margins of chelicerae with 2 and 3 teeth (Fig. 8) respectively; epigyne as in Fig. 11 .... *nareshi* sp. nov.

— Abdomen postero-medially wide (Fig. 13); cephalic region strongly raised and produced (Fig. 13); sternum heart-shaped, medially with a V-shaped area (Fig. 16); each of inner and outer margins of chelicerae with 2 teeth (Fig. 14); epigyne as in Fig. 17 .... *lahirii* sp. nov.

Cyrtophora cicatrosa (Stoliczka)
(Figs 1-6)

1869. *Epeira* (*Nephila*) *cicatrosa* Stoliczka, *J. Asiatic Soc. Beng.* *33*: 242.

1900. *Araneus cicatrosa*: Pocock, *Fauna Brit. India, Arach.*: 226.

1935. *Cyrtophora cicatrosa*: Dyal, *Bull. Zool. Panjab Univ. 1*: 175.

1962. *Cyrtophora cicatrosa*: Tikader, *J. Linn. Soc. 44*(300): 563.

1982. *Cyrtophora cicatrosa*: Tikader, *Fauna of India, Araneae: Spiders 2(1)*: 178.

1997. *Cyrtophora cicatrosa*: Biswas *et al.*, *Entomon 22(3 & 4)*: 230.

Material examined: 1 ♀, Khulna, 10.x.1993, Coll. V. Biswas; 2 ♀ ♀, Manikganj, 12.v.1992, Coll. V. Biswas; 1 ♀, Rajshahi, 3.iii.1992, Coll. V. Biswas.

Distribution: Bangladesh: Khulna, Manikganj, Rajshahi, Jessore; India; Pakistan; Burma (Myanmar); Malaysia; New Guinea; Australia (Tikader 1982).

Cyrtophora nareshi sp. nov.

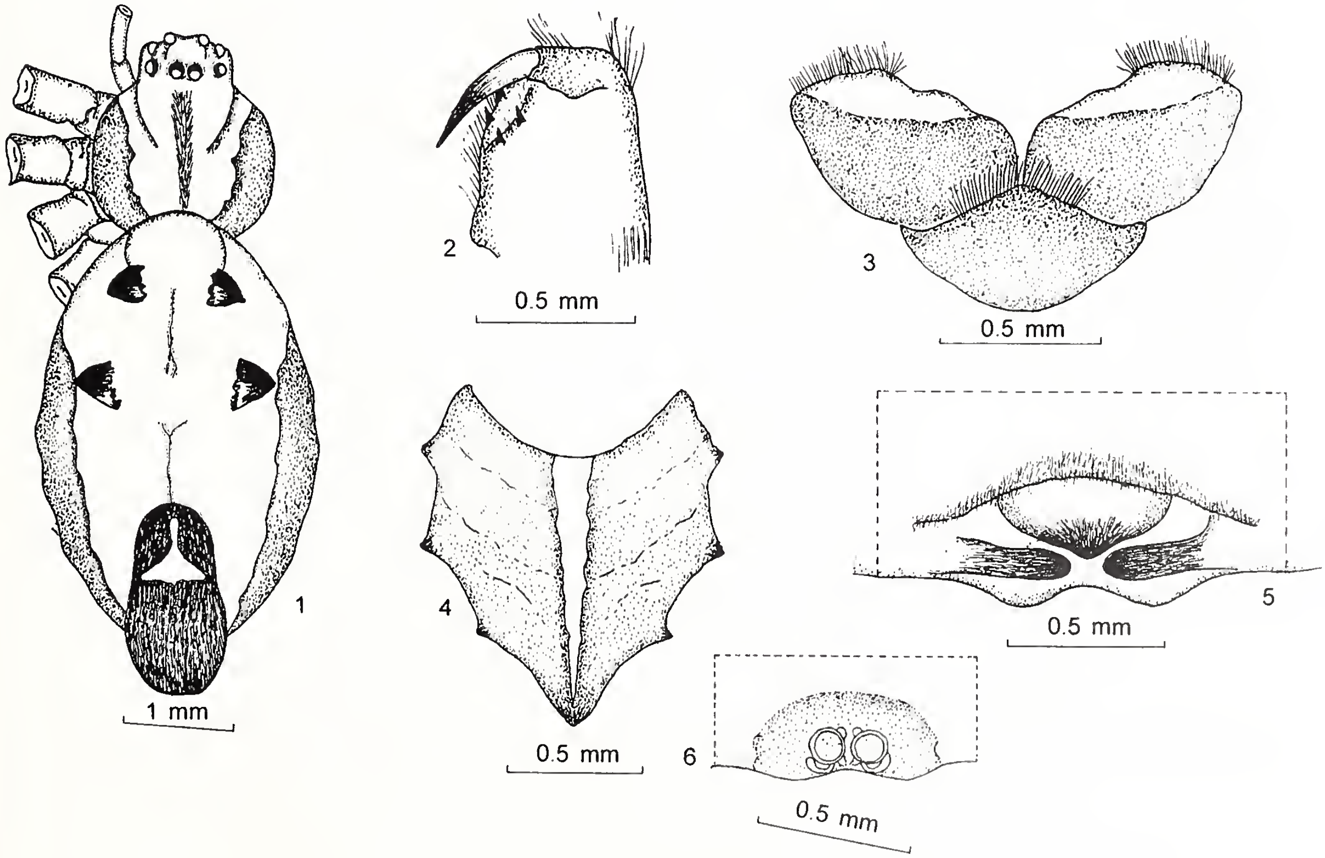
(Figs 7-12)

Holotype (Female): Measurements (in mm): Total body length 6.00; carapace length 2.00, width 2.10; abdominal length 4.00, width 4.10. Legs as in Table 1.

Colour (specimens preserved in alcohol): Cephalothorax yellow-green; legs brown-yellow with white markings. Abdomen decorated with various markings. Abdomen dark yellow.

Carapace: Longer than wide, anteriorly narrowing, posteriorly wide; dorsum with white, median decorated area (Fig. 7); cephalic region slightly raised; eyes brown and pearly-white, dissimilar; lateral eyes larger than others; anterior row recurved and posterior row procurved; anteromedians situated on a protuberance; ocular-quad longer than wide, anteriorly narrowing and posteriorly wide; chelicerae brown, long, nearly parallel sided, inner and outer margins of chelicerae with 2 and 3 teeth respectively (Fig. 8); maxillae brown, long, boat-shaped, medially wide, scopulate (Fig. 9); labium pale brown, pot-like, wider than long, scopulate (Fig. 9); sternum brown, with U-shaped, white reticulate longitudinal area, nearly heart-shaped, bluntly pointed, sparsely spined posteriorly, anterior margin concave (Fig. 10); legs long and slender, clothed with hairs and spines; leg formula 1 2 4 3 and measurements as in Table 1.

Abdomen: Elongate, oval, parallel sided, posterior extremity narrow; dorsum with brown and white, few



Figs 1-6: *Cyrtophora cicatrosa* (Stoliczka), 1. Female dorsal view (legs omitted), 2. Chelicerae, 3. Maxillae and Labium, 4. Sternum, 5. Epigynum, 6. Internal genitalia

Table 1: Leg segments of *Cyrtophora nareshi* sp. nov. ♀ measurements (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.0/7.0	2.0/2.0	5.0/5.0	7.0/7.0	2.0/2.0	23.0/23.0
II	7.0/7.0	1.5/1.5	5.0/5.0	7.0/7.0	1.9/1.9	22.4/22.4
III	4.0/4.0	1.0/1.0	3.0/3.0	3.0/3.0	1.2/1.2	12.2/12.2
IV	7.0/7.0	1.5/1.5	4.0/4.0	6.5/6.5	2.0/2.0	21.0/21.0
Palps	3.1/3.1	2.0/2.0	2.5/2.5	—	1.0/1.0	8.6/8.6

sigilla and brown spots; epigyne and internal genitalia as in Figs 11 and 12.

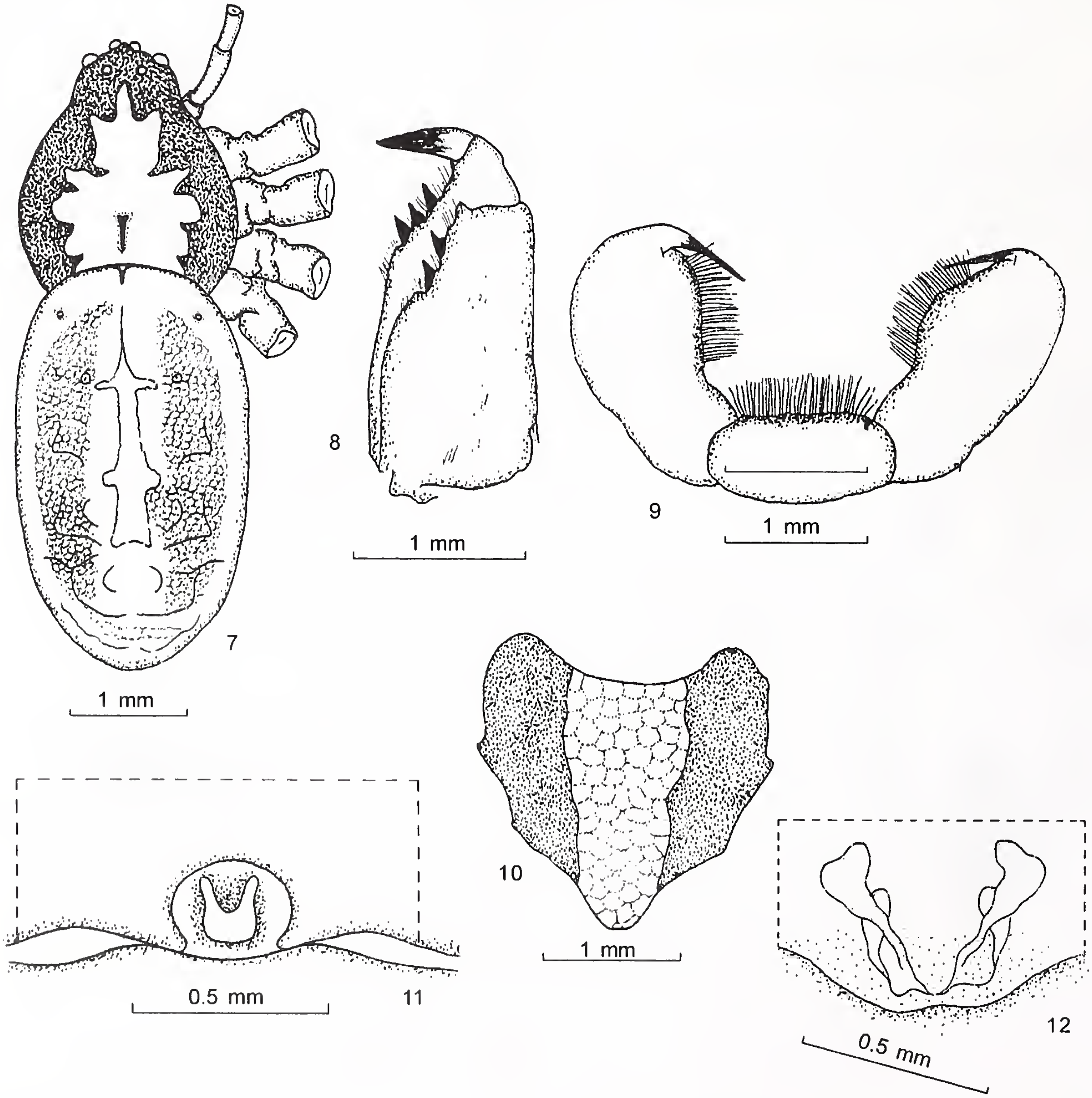
Specimens examined: Holotype ♀, 3.iii.1992, Coll. V. Biswas. Paratype; 1 ♀, other data same as holotype.

Type locality: Digha, Rajshahi, Bangladesh.

Male: Unknown.

Distribution: BANGLADESH: Rajshahi (known only from the type locality).

Etymology: The species is named after Prof. Naresh Chandra Dutta, Department of Zoology, University of Calcutta, India, who was a source of inspiration.



Figs 7-12: *Cyrtophora nareshi* sp. nov., 7. Female dorsal view (legs omitted), 8. Chelicerae, 9. Maxillae and Labium, 10. Sternum, 11. Epigynum, 12. Internal genitalia

Remarks: The new species is close to *Cyrtophora lahirii* sp. nov. but differs as follows:

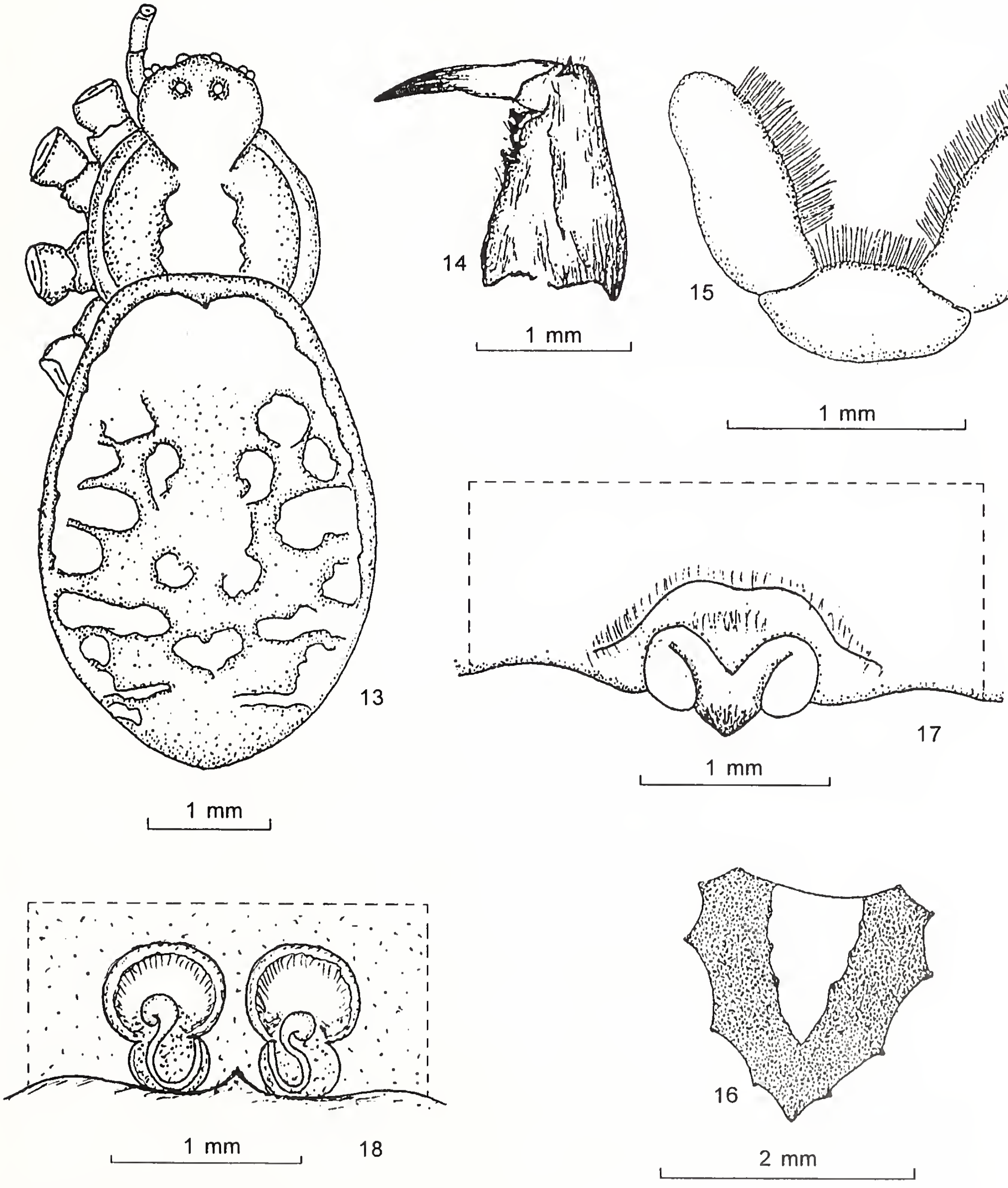
1. Cephalothorax with deep and distinct fovea, whereas in *C. lahirii* sp. nov. fovea absent.
2. Abdomen dorsally reticulate, but in *C. lahirii* sp. nov. it is nearly alveolate.
3. Sternum medially reticulate, whereas in *C. lahirii* sp. nov. it is white medially.
4. Outer margin of chelicerae with 3 teeth, but in *C. lahirii* it is 2 in number.
5. Epigyne of both the species structurally different.

Cyrtophora lahirii sp. nov.
(Figs 13-18)

Holotype (Female): Measurements (in mm). Total length 6.10; carapace length 2.20, width 2.00; abdominal length 3.8, width 4.10. Legs as in Table 2.

Colour (specimens preserved in alcohol): Cephalothorax yellow-brown; legs light brown with brown bands; abdomen brown with white patches.

Carapace: Longer than wide, wider posteriorly; cephalic region raised, produced, sphere shaped,



Figs 13-18: *Cyrtophora lahirii* sp. nov., 13. Female dorsal view (legs omitted), 14. Chelicerae, 15. Maxillae and Labium, 16. Sternum, 17. Epigynum, 18. Internal genitalia

Table 2: Leg segments of *Cyrtophora lahirii* sp. nov. ♀ measurements (in mm)

Leg	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	7.0/7.0	1.0/1.0	5.0/5.0	6.0/6.0	2.5/2.5	21.5/21.5
II	7.0/7.0	2.0/2.0	4.5/4.5	7.0/7.0	2.0/2.0	22.5/22.5
III	4.0/4.0	1.0/1.0	2.0/2.0	3.0/3.0	1.5/1.5	11.5/11.5
IV	5.5/5.5	1.5/1.5	4.4/4.4	6.0/6.0	2.0/2.0	19.4/19.4
Palps	3.0/3.0	1.0/1.0	2.0/2.0	—	1.1/1.1	7.1/7.1

with 2 deeply distinct cervical furrows (Fig. 13); eyes brown, similar; anterior row recurved and posterior row procurved; lateral eyes close and placed marginally; ocular quad squarish; chelicerae long, cylindrical, inner and outer margins with 2 teeth each (Fig. 14); maxillae long, longer than wide and scopulate anteriorly (Fig. 15); labium brown, bowl-shaped and scopulate anteriorly (Fig. 15); sternum dark-brown, heart-shaped, with a white V-shaped longitudinal region, anterior margin concave; legs long, slender, leg formula 2 1 4 3 and measurements as in Table 2.

Abdomen: Broadly oval, longer than wide, narrowing at both ends (Fig. 13); dorsum decorated; ventrally pale, with a longitudinal brown patch extending from epigastric furrow up to the spinnerets; epigyne as in Fig. 17.

Specimens examined: Holotype: ♀, 12.v.1993, Coll. V. Biswas; Paratypes: 1♀, other data same as holotype and 1♀, Narail, Bangladesh, 5.vii.1992, Coll. V. Biswas.

Type locality: Magura, Bangladesh.

Male: Unknown.

Distribution: BANGLADESH: Magura, Narail.

Etymology: The species has been named after Dr. Pulak Lahiri, Professor, Department of Zoology, University of Calcutta, India, for his extreme interest in the work.

Remarks: The new species at best may be related to a Chinese species *Cyrtophora guangxiensis* Yin *et al.* (Yin *et al.* 1990) in having cephalic region greatly produced, cervical furrows deeply distinct and ovoid abdomen. The species stands distinct in having fovea and markedly different epigynum. The species also does not show any resemblance in general appearance as well as epigyne and internal genitalia, which are different from those of its Indian congeners.

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TWO NEW SPECIES OF *PUNTIUS* HAMILTON-BUCHANAN (CYPRINIFORMES: CYPRINIDAE) FROM MANIPUR, INDIA, WITH AN ACCOUNT OF *PUNTIUS* SPECIES FROM THE STATE[1]

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This paper gives the diagnostic characters of ten species and detailed description of two new species of the genus *Puntius* Hamilton-Buchanan from Manipur. *P. javanicus* and *P. stoliczkanus* are recorded for the first time from the state. *P. ornatus* sp. nov. differs from *P. phutunio* in banding pattern (a single dark transverse band at the 18th-20th lateral line scale around caudal peduncle vs. four dark bands on body). *P. bizonatus* sp. nov. also differs from *P. phutunio* in body form and banding pattern (two dark transverse bands vs. four on the body). A key to the species of *Puntius* of Manipur is provided.

Key words: Fish, genus *Puntius*, Manipur, *Puntius ornatus* sp. nov, *Puntius bizonatus* sp. nov.

INTRODUCTION

Hora (1921) listed and gave a brief systematic account of eight species of *Barbus* Cuvier from Manipur, of which only four are now included in the genus *Puntius* Hamilton-Buchanan. They are: *P. sarana* (Val.), *P. ticto ticto* (Ham.-Buch.), *P. conchonius* (Ham.-Buch.) and *P. phutunio* (Ham.-Buch.). He identified *P. phutunio* based on the field notebook of Dr. Annandale. Later reports on the fishes of Manipur by Menon (1952), and Menon (1954) did not include additional species of the genus. Vishwanath and Singh (1986) described *P. jayarami* Vishwanath & Tombi. Menon *et al.* (2000) compared specimens of fishes collected from Loktak lake, supposedly identified as *P. phutunio* by Hora (1921) with typical *P. phutunio* collected by W. Rainboth and A. Rahman from Rangpur, Dharala river in Bangladesh. The Manipur specimen turned out to be new and was described as *P. manipurensis* by Menon *et al.* (2000). *P. chola* (Ham.-Buch.) and *P. sophore* (Ham.-Buch.) were first reported by Vishwanath *et al.* (1998) from Chatrickong and Lokchao rivers in Manipur. A recent survey of the fishes of Manipur included twelve species of *Puntius*, including two new species. *P. stoliczkanus* (Day) is recorded for the first time from the State. *P. javanicus* (Bleeker) is an introduced species. This paper gives detailed descriptions of the two new species and diagnostic characters of ten species.

MATERIAL AND METHODS

Type specimens of the two new species, namely *Puntius ornatus* and *P. bizonatus* are deposited in the Manipur University Museum of Fishes (MUMF). Measurements and counts follow Jayaram (1999). The body proportions are expressed as percentages of standard length (SL) and head length (HL). For the paratypes, the mean values are given first, followed in parentheses by range as percentages.

Abbreviations used: JL = Juliana Laisram, KNS = K. Nebeshwor Sharma, MSS = M. Shantakumar Sharma; KBD = K. Bimola Devi; R = river; WV = W. Vishwanath.

KEY TO SPECIES

1. Barbels absent 2
— Barbels present 8
2. Dark circular band around caudal peduncle 3
— No dark circular band around caudal peduncle 4
3. One black band forming a ring around caudal peduncle .... *P. ornatus*
— One black band forming a ring around caudal peduncle and one transverse band on 3rd-4th lateral line scale .... *P. bizonatus*
4. Dorsal spine smooth .... *P. sophore*
— Dorsal spine serrated posteriorly 5
5. Lateral line complete .... *P. stoliczkanus*
— Lateral line incomplete 6
6. Scales from dorsal fin origin to lateral line 3, pores on lateral line 3 to 5 .... *P. manipurensis*
— Scales from dorsal fin origin to lateral line more than 3, pores on lateral line 5 or more 7
7. Dorsal fin tipped with black .... *P. conchonius*
— Dorsal fin not tipped with black .... *P. ticto ticto*
8. Barbels 1 pair, body marked with two conspicuous dark blotches, first behind operculum and second near base of caudal fin .... *P. chola*
— Barbels 2 pairs, body without dark blotches 9

9. Dorsal spine finely serrated posteriorly 10
— Dorsal spine strongly serrated posteriorly 11
10. Scales from dorsal fin origin to lateral line 6 .... *P. orphoides*
— Scales from dorsal fin origin to lateral line 5 .... *P. sarana*
11. Lateral transverse scales 5/1/3 .... *P. jayarami*
— Lateral transverse scales 6/1/4 .... *P. javanicus*

Puntius bizonatus **sp. nov.**
(Fig. 1)

Holotype: MUMF 3017., 35.8 mm SL. Lokchao R., Moreh. 24-26.iii.1999, WV & party.

Paratypes: MUMF 3017A/5., 26.9-39.4 mm SL., Lokchao R., Moreh, same collection data as holotype.

Description: D. iii, 8; P. i, 13; V. i, 8; A. iii, 5; C. 9+8. Proportional measurements and counts are in Table 1. A small sized *Puntius* with two dark transverse bands across the body. Body deep, 37(36.5-39.6)% of SL. Barbels absent. Both dorsal and ventral profiles slightly curved. Mouth small, subterminal and crescentic, snout smooth (23-26% HL), eyes moderate, visible from ventral side, scales large. Origin of dorsal fin slightly behind that of ventral origin, its last simple ray serrated and shorter than body depth. Pectoral fin does not reach anterior origin of ventral fin and the latter does not reach anal origin. Dorsal fin inserted midway between tip of snout and base of caudal fin. It has a few black streaks with the last simple ray osseous and serrated. Other fins dusky. Caudal fin deeply forked. Lateral line incomplete, 4-9 piercing scales; 21 in longitudinal series and 8 in rows. Branchiostegal rays 3. Pharyngeal teeth in 3 rows 2,3,5-5,3,2. Gill rakers 5+15-18.

Colour: Silvery white. Two vertical black bands on body; the anterior at the third to fourth scales of lateral line; the other on the caudal peduncle, 4-5 scales ahead of the caudal fin rays. Dorsal fin reddish, streaked with black. Pectoral and pelvic fins dusky, anal fin reddish, caudal with dark margin. Scales have blackish streaks on the dorsal part of body.

Distribution: India: Lokchao R., Moreh, Manipur.

Etymology: This species is named after the bizonal bands on its body.

Remarks: It is abundantly found only in the Chindwin drainage in Manipur. The beautiful bizonal bands give the fish an attractive appearance, which may prove to be a good aquarium fish. *P. bizonatus* is similar to *P. phutunio* in having dark bands on body, finely serrated osseous dorsal fin ray. However, it differs in having only two bands, one on 3rd-4th scale of lateral line and another at caudal peduncle vs. four bands on *P. phutunio*. The former also has a shorter snout length (5.9 vs. 7.8% of SL) and narrower inter-orbital space (9.9 vs. 11.3% of SL).

The species under description differs from *P. cumingi* in having a lateral line series of 22 vs. 19-21, lateral transverse scales of 4/1/2 vs. 3½-4/1/3½, circumpeduncular scales of 12 vs. 8-10, pre-anal scales of 14-15 vs. 10-11, pre-pelvic scales of 8-10 vs. 5-6, gill rakers of 5+15-18 vs. 9+13. *P. cumingi* however, is distributed only in Sri Lanka. It differs from *P. puntio* in having two bands vs. one, one osseous and serrated last simple dorsal fin ray vs. weakly osseous and smooth one, incomplete lateral line of 5-7 pores vs. a complete one. *P. bizonatus* differs from *P. gelius* in having two bands vs. three bands, lateral line series of 22 vs. 23-24, lateral transverse scales of 4/1/2 vs. 4-5/1/3-4, circumpeduncular scales of 12 vs. 6-8, pre-anal scales of 14-15 vs. 13 and pre-pelvic scales of 8-10 vs. 6 scales. Comparison of the new species with its related species is given in Table 2.

Maximum SL: 39.4 mm

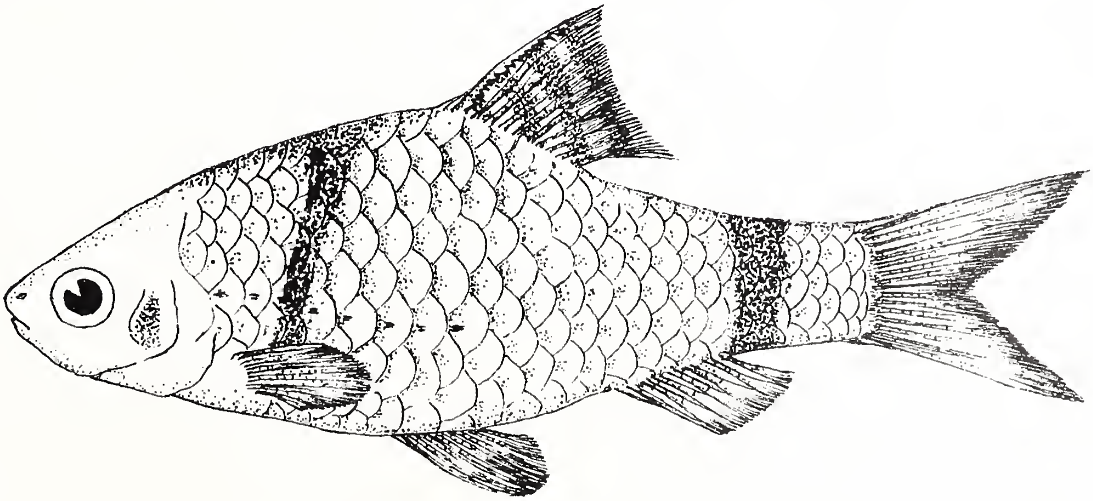

Fig.1: *Puntius bizonatus* sp. nov.

Table 1: Morphometric data of *P. ornatus* sp. nov., *P. phutunio* (Ham.) and *P. bizonatus* sp. nov. in % SL (except SL given in mm)

	P. ornatus sp. nov			*P. phutunio*	*P. bizonatus* sp. nov		
	Holotype MUMF 3028	Paratypes MUMF 3028 A/7 MUMF 3028B/2	S.D	(Ham) ZSI F10929/1	Holotype MUMF 3017	Paratypes MUMF 3017 A/5	S.D
Standard Length	42.0	30.9-42.0		28.4	35.8	26.9-39.4	
Body depth	35.0	35.9(34.7-38.7)	1.9	39.8	35.8	37.8(36.5-39.6)	1.6
Caudal length	29.3	29.2(24.7-32.2)	2.3	34.9	32.4	28.3(25.3-29.7)	2.2
Head length	27.4	26.4 (24.5-27.4)	1.1	27.8	26.0	25.9(24.4-27.5)	1.0
Head depth (at occiput)	22.4	20.9(20.0-22.5)	0.9	24.3	23.2	22.2(20.7-23.9)	1.1
Head depth (at eye)	15.7	15.5(14.0-17.1)	0.8	18.0	16.8	16.5(15.5-17.1)	0.5
Snout length	5.7	5.9(4.8-7.5)	1.0	7.8	5.6	5.9(5.2-7.1)	0.6
Eye diameter	7.9	8.5(7.9-10.8)	0.9	9.2	8.1	8.2(7.5-8.9)	0.5
Inter-orbital space	8.8	9.9(9.2-10.8)	0.6	11.3	9.5	9.0(7.7-10.2)	0.9
Head width (at nares)	9.5	8.6(6.9-9.3)	0.7	-	8.4	8.5(7.7-9.3)	0.6
Max. head width	15.2	14.0(12.9-14.6)	0.7	16.6	15.4	14.1(12.7-15.1)	1.0
Gape width	5.7	4.8(4.2-5.2)	0.4	6.0	6.1	5.8(5.1-6.3)	0.4
Inter-narial space	5.5	5.5(4.4-6.2)	0.5	7.4	4.7	4.8(4.1-6.3)	0.7
Body width (dorsal origin)	15.2	15.7(9.6-17.5)	2.1	-	15.6	14.7(12.3-16.1)	1.4
Body width (at anal origin)	11.0	10.3(8.4-11.5)	1.2	-	11.5	10.6(8.6-11.9)	1.2
Length of Caudal ped.	16.4	17.0(15.5-21.7)	2.1	15.1	19.8	16.1(15.2-18.0)	1.8
Height of Caudal ped.	13.8	13.5(12.6-15.1)	0.8	16.2	15.1	4.6(13.7-15.1)	0.5
Pre-dorsal length	54.8	50.8(48.2-53.3)	2.4	46.8	50.8	48.9(46.7-51.3)	1.9
Post-dorsal length	45.5	49.4(45.2-54.6)	3.2	51.4	50.8	49.5(47.5-51.7)	1.7
Pre-pelvic length	51.2	50.0(44.3-50.1)	2.4	47.2	50.0	45.0(34.3-48.6)	5.5
Pre-anal length	73.6	72.1(66.1-74.0)	2.6	70.1	72.3	69.6(68.4-71.1)	1.4
Pre-anus length	73.1	69.2(65.5-71.8)	2.4	69.7	71.2	67.1(65.8-69.5)	2.2
Dorsal fin base length	14.8	16.0(14.6-16.9)	0.9	19.0	18.4	17.5(16.2-19.5)	1.1
Dorsal fin height	21.4	20.0(17.2-24.9)	2.4	21.5	19.6	20.9(18.4-22.1)	1.5
Pectoral fin length	18.8	19.1(16.9-21.1)	1.3	23.6	22.3	20.3(18.1-22.0)	7.6
Ventral fin length	20.2	20.5(18.4-22.9)	1.3	25.0	20.7	20.9(19.0-22.9)	1.2
Anal fin base length	8.8	8.9(8.1-10.7)	0.8	12.7	11.2	10.9(10.0-13.0)	2.9
Anal fin height	14.5	16.2(15.5-18.4)	1.3	-	17.9	17.9(15.7-19.7)	3.3
Pre-dorsal scales	9	8-9		8	8	8	
Circumped. scales	12	11		13	12	12	
Pre-pelvic scales	10	11		9	9	8-10	
Pre-anal scales	16	18		16	13	14-15	
Lateral line series	24	20-25		20	21	22	
Lateral line rows	8	8		8	8	9	
Lateral line pores	9	5-9 and 22		5	9	5-7	
LCP/HCP	1.2	1.3		0.9	1.3	1.1	

Puntius ornatus sp. nov.
(Fig. 2)

Holotype: MUMF 3028, 42.0 mm. SL, Lokchao R., Moreh, 24.iii.1999, WV and party.

Paratypes: MUMF 3028 A/7., 30.9-42.0 mm SL, same collection data as holotype. MUMF 3028B/2., 45.1 mm SL, Lokchao R., Moreh, 14.vii.2000, KNS & MSS.

Description: D. iii, 8; P. i, 11-12; V. i, 8; A. iii, 5-6; C. 9+8. Proportional measurements and counts are given in Table 1. A small sized *Puntius* with a wide rounded dark band around caudal peduncle. Body moderately deep, its depth longer than head length (35.9% in SL). Both dorsal and ventral profile slightly curved. Mouth small, subterminal and crescentic, without any barbels. Eyes and scales moderate, eyes visible from ventral surface, snout smooth. Caudal peduncle slender. Dorsal fin inserted nearer caudal fin base than snout tip, its last simple ray osseous, serrated posteriorly, shorter than body depth. Pectoral fin inserted in a line vertical to the gill opening, does not reach anterior origin of

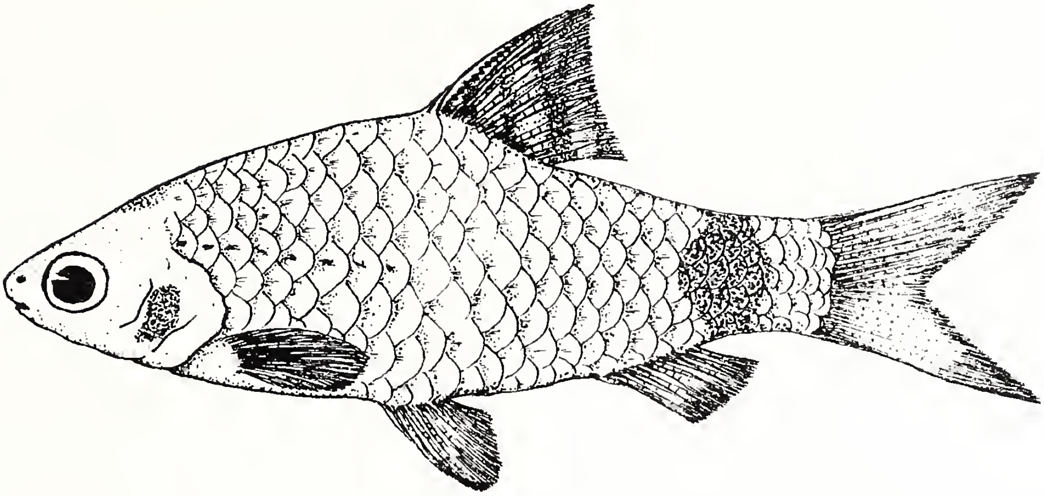

Fig. 2: *Puntius ornatus* sp. nov.

ventral fin and the latter does not reach anal opening. Caudal fin deeply forked. Lateral line with 5-21 pores. Scales on lateral line series 23-24. Predorsal scales 8 or 9. Gill rakers 5+18, pharyngeal teeth low and weak, in three rows 2,3,5 - 5,3,2. Branchiostegal rays 3.

Colour: Silvery, flanks sometimes shot with reddish tinge. Wide rounded dark band around caudal peduncle, middle portion of band darker and rounded. Dorsal fin orange, tipped with black and a few rows of streaks. Pectoral and pelvic fins dusky. Anal fin yellowish, caudal with a dark margin. The scales are edged with black in the dorsal part of the body.

Distribution: India: Lokchao R., Moreh, Manipur.

Etymology: This species is named after its ornamental band around the caudal peduncle.

Remarks: The species is small, but attractive, and can be a popular aquarium fish. *P. ornatus* sp. nov. is similar to *P. phutunio* in having finely serrated and osseous last simple dorsal fin ray and in the absence of barbels. However, the new species is different in banding pattern, namely a single dark transverse band encircling the caudal peduncle (18-20th scale of lateral line) vs. four dark bands: first over pectoral, second from below dorsal spine, third from posterior end of dorsal and fourth across caudal peduncle. It also differs from *P. phutunio* in having a more slender caudal peduncle (depth of caudal peduncle 9.9(8.4-11.5)% of SL vs. 16.2% of SL). *P. ornatus* may have a complete or incomplete lateral line, whereas *P. phutunio* always has an incomplete lateral line.

Puntius ornatus differs from *P. cumingi* in having a single band forming a ring around the caudal peduncle vs. two bands, lateral line series of 20-25 vs. 19-21, lateral transverse scale of 4½/1/2½ vs. 3½-4/1/3½, circumpeduncular scales of 11-12 vs. 8-10, pre-anal scales of 18 vs. 10-11. It differs from *P. gelius* in having a single band vs. three bands, circumpeduncular scale of 11-12 vs. 6-8, pre-anal scales of 18 vs. 13, and pre-pelvic scales of 11 vs. 6. It greatly differs from *P. puntio*, which also has a single band around the caudal peduncle, having an osseous, serrated last unbranched dorsal fin ray vs. weakly osseous and smooth last unbranched dorsal fin ray. It also differs from *P. puntio* in having a variably incomplete lateral line vs. a complete lateral line. Comparison of the new species with its related species is given in Table 2.

Maximum SL: 42 mm.

Comparative Material: *Puntius phutunio*, ZSI F10929/1, Rocky streams around Kamaing, Myitkyina district, Upper Burma, December 23-30, 1926, B. Chopra.

Puntius chola (Hamilton-Buchanan)

Cyprinus chola Hamilton-Buchanan, 1822, *Fish. Ganges*: 312, 389 (type locality: North eastern part of Bengal)

Material examined: MUMF 3020/2., 44.6-61.9 mm SL, Kharungpat, 21.viii.1998, KBD; MUMF 3021/1., 71.3 mm SL, Lokchao R., Moreh, 24-26.iii.1999, WV & party.

Local Name: Phabou nga (Manipuri).

Diagnosis: A *Puntius* with a deep and compressed body. A single maxillary pair of barbels present. Last simple dorsal ray moderately strong and smooth. Lateral line complete with 24-28 scales. Scales from dorsal fin origin to lateral line 6 and those from lateral line to pelvic fin origin 4. Predorsal scales 11, circumpeduncular scales 14, pre-pelvic scales 11, pre-anal scales 19.

Colour: Body silvery, with olive green dorsally, a black blotch at the far end of the caudal peduncle between 21st and 23rd lateral line scales and another at the base of anterior dorsal fin ray. A dark blotch may or may not be present behind operculum.

Distribution: INDIA: Throughout; Bangladesh, Myanmar, Pakistan, Sri Lanka, Nepal.

Remarks: The bright colouration of this fish especially during breeding season gives good ornamental value. Vishwanath *et al.* (1998) reported it from Chatrickong river in Manipur for the first time.

Puntius conchonius (Hamilton-Buchanan)

Cyprinus conchonius Hamilton-Buchanan. *Fish. Ganges*: 317, 389; Cuv. and Val. xvi, p. 394.

Material examined: MUMF 3027/3., 44.6-47.8 mm SL, Barak R., 5.viii.1999, KNS.

Local name: Phabou nga (Manipuri).

Diagnosis: A *Puntius* with no barbels, incomplete lateral line, pores ending after 7-12 scales, 5 scales between origin of dorsal fin and lateral line and 4 between lateral line and root of pelvic fin. Predorsal scales 8, circumpeduncular scales 12, pre-pelvic scales 12, pre-anal scales 18. Body comparatively deep (39.7-44.2% SL). Last simple dorsal ray osseous, moderately strong and serrated, its height less than head length.

Colour: A big black blotch on the caudal peduncle and a faint one near the operculum, which may be absent. Fins yellow and red. Dorsal fin tipped with a black blotch.

Distribution: INDIA: Brahmaputra, Barak, Ganga, Mahanadi, Cauvery rivers. PAKISTAN: Punjab.

Remarks: Very similar to *P. stoliczkanus* Day but differs in having incomplete lateral line and dorsal fin tipped with a black blotch. It is an ornamental fish commonly known as Rosy Barb.

Puntius javanicus (Bleeker)

Barbus gonionotus Bleeker, *Verh. Bat. Gen.* xiii. (1849) 1850, *Ichth. Midden Oost -Java,* p. 15.

Material examined: MUMF 3031/1., 191.8 mm SL, cultivated species.

Local name: Japan puthi (Manipuri).

Diagnosis: A medium sized *Puntius* with four barbels, complete lateral line with 30 pores. Scales from dorsal fin origin to lateral line 6 and from lateral line to pelvic fin origin 4, predorsal scales 11, circumpeduncular scales 19, pre-pelvic scales 15, pre-anal scales 25, last unbranched dorsal ray strong, osseous and serrated. Depth of body high (40.3% SL). Anal and dorsal fins emarginate.

Colour: Flanks are bright golden with a darker tinge dorsally. Fins reddish.

Remarks: This moderately sized fish is an introduced species to Manipur. It is rarely sold in the market. Eschmeyer (1998) puts this species under *Barbus* Cuvier.

Puntius jayarami Vishwanath & Tombi

Puntius jayarami Vishwanath & Tombi, 1986. *Rec. zool. Surv. India, 83 (1&2)*: 129, Fig. I (type locality: Chakpi stream, Chakpikarong, Manipur); Jayaram 1991, *Rec. zool. Surv. India*, Occ. Paper No. 135: 124 (revision)

Material examined: MUMF 3023/2., 82.9-92.7 mm SL, Lokchao R., Moreh, 24-26.iii.1999, WV and party.

Local name: Heikak nga / Naphet nga.

Diagnosis: A *Puntius* species with four barbels, complete lateral line with 28-30 pores, 5 scales from lateral line to origin of dorsal fin and 3 from lateral line to origin of pelvic fin. Predorsal scales 10, circumpeduncular scales 13-14, pre-pelvic scales 17, pre-anal scales 27, last unbranched dorsal ray osseous, strong and denticulate. Snout pointed. Eyes moderate.

Colour: Silvery with reddish fins.

Distribution: INDIA: Manipur river, Manipur.

Puntius manipurensis Menon, Rema Devi & Vishwanath

Puntius manipurensis Menon, Rema Devi & Vishwanath 2000. *J. Bombay nat. Hist. Soc. 97(2)*: 263-268.

Material examined: MUMF 3026/2., 38.8-45.4 mm SL., Manipur R., 15.ix.1998, WV. MUMF 3027/2., 31.1-34.2 mm SL, Canchipur, 16.vii.1999, JL.

Local name: Ngakha meingangbi (Manipuri).

Diagnosis: A *Puntius* with no barbels, incomplete lateral line. Perforated scales 3-5. 20 scales in lateral line series and 8 lateral transverse rows of scales. Predorsal scales 9, circumpeduncular scales 8, pre-pelvic scales 10, pre-anal scales 16, last unbranched dorsal ray osseous, serrated.

Colour: Body dark silvery, with two black blotches, one at the 3rd-4th scale near the operculum and the other at the 17th scale near the caudal peduncle; these are less distinct than in *P. ticto*. The fins and caudal peduncle scarlet red in colour; males are more brightly coloured. Their scales, especially on the dorsal part of body have black dots. Females exhibit a subdued pink on the body and fins.

Distribution: INDIA: Manipur valley.

Table 2: Morphometry and distribution of some banded *Puntius* species

Characters	*Puntius cumingi* (Gunther), 1868	*Puntius puntio* (Hamilton), 1822	*Puntius gelius* (Hamilton), 1822	*Puntius phutunio* (Hamilton), 1822	*Puntius omatus* sp. nov.	*Puntius bizonatus* sp. nov.
No. of barbels	nil	nil	nil	nil	nil	nil
Last unbranched dorsal ray	osseous, serrated	weakly osseous smooth	osseous, serrated	osseous, serrated	osseous, serrated	osseous, serrated
Lateral line	incomplete after 5-6 scales	complete	incomplete after 4-6 scales	incomplete after 3-5 scales	incomplete after 5-22 scales	incomplete after 5-7 scales
Lateral line scales	19-21	23	23-24	20-23	20-25	22
Lateral transverse	3½-4/1/3½	5/1/2½	4-5/1/3-4	3½-4/1/3	4½/1/2½	4/1/2
Pre-dorsal scales	9-11	8	8	8	8-9	8
Circumpeduncular scales	8-10	-	6-8	13	11-12	12
Pre-anal scales	10-11	-	13	16	18	14-15
Pre-pelvic scales	5-6	-	6	9	11	8-10
Gill rakers	9+13	-	-	0+9	5+18	5+15-18
LCP/HCP	1.6-1.75	-	1.2-3.0	0.9	1.3	1.1-1.3
Colour	two vertical black bands; one above pectoral and another above anal fins	single broad vertical band around caudal peduncle	three black bands; one over occiput, another over anal fin and a third over caudal peduncle	four dark bands; first over pectoral fin, second from below dorsal spine, third from posterior end of dorsal and fourth across caudal peduncle	a single black band around caudal peduncle forming a ring	two black bands; one around caudal peduncle and another transverse over 3rd-4th scale anteriorly
Distribution	Sri Lanka	India: West Bengal. Burma (now Myanmar)	India: Orissa, West Bengal, Assam	Widely distributed	India: Lokchao R. Manipur	India: Lokchao R. Manipur

Remarks: Although not of much food value because of its small size, it holds a good prospect as an ornamental fish. In the breeding season, i.e. July-August, the males give chase to the female.

Puntius orphoides (Valenciennes)

Barbus orphoides Valenciennes, 1842, *Hist. nat. Poiss., 16*: 193 (type locality: Java)

Materials examined: MUMF 3025/2., 77.9-78.0 mm, Lokchao R., Moreh, 24-26.iii.1999, WV and party.

Local name: Nganoi/ Ngahou (Manipuri).

Diagnosis: A *Puntius* species with four barbels, lateral line complete with 28-29 pores. Scales from dorsal fin origin to lateral line 6 and from lateral line to pelvic fin origin 4, predorsal scales 11-12, prepelvic scales 12-14. Last unbranched dorsal ray osseous, strong and serrated, circumpeduncular scales 14-16. Depth of body 33-36% of SL. Anal and dorsal fins not emarginated.

Colour: Silvery with reddish fins.

Distribution: INDIA: Loktak lake, Imphal, Manipur. Borneo, Java, Malaya, Myanmar, Thailand.

Remarks: Once reported to be plentiful in the central plain. At present very rare in the valley. A fish of good food value.

Puntius sarana (Hamilton-Buchanan)

Cyprinus sarana Hamilton-Buchanan, 1822, *Fish. Ganges*: 307 (type locality: ponds and rivers of Bengal).

Materials examined: MUMF 3024/1., 195 mm, Jiri R., Jiribam, 19.ix.1998, WV and party.

Local Name: Nganoi/Ngahou (Manipuri).

Diagnosis: Body deep and compressed, its depth 34.2% of standard length. Barbels two pairs, rostral as long as orbit, maxillary longer. Dorsal fin inserted slightly ahead of the middle of the body. Dorsal spine osseous and finely serrated posteriorly. Lateral line complete with 32 scales. 5 scales above lateral line row and 4 below it. Predorsal scales 9, circumpeduncular scales 16, pre-pelvic scales 19, pre-anal scales 27.

Colour: Silvery white, olivaceous dorsally. Body with a golden reflection, cheeks golden. Fins dusky brown to orange.

Distribution: Afghanistan. Pakistan. India: Ganga-Brahmaputra drainage, peninsular India north of Krishna river.

Remarks: Found only in Barak drainage in Manipur. Eschmeyer (1998) puts this species under genus *Barbus* Cuvier.

Puntius sophore (Hamilton-Buchanan)

Cyprinus sophore Hamilton-Buchanan, 1822, *Fish. Ganges*: 310, 389 (type locality: ponds and rivers of Gangetic Provinces)

Material examined: MUMF 3021/1., 71.3 mm SL, Lokchao R, Moreh. 24-26.iii.1999, WV & party.

Local name: Phabou nga (Manipuri), Nga-khon-ma (Burmese)

Diagnosis: This species has a relatively deep body, its dorsal profile more convex than ventral. Head short, mouth terminal. Dorsal fin inserted equidistant between tip of snout and base of caudal fin. Dorsal spine osseous and smooth, lateral line complete with 23-24 pores, 4 scales above lateral line and 3 from lateral line to pelvic fin origin. Predorsal scales 8-10, circumpeduncular scales 12, pre-pelvic scales 12, pre-anal scales 16-17, barbels absent.

Colour: Silvery, back grey-green to brownish; flanks with a somewhat bluish lustre, underside white. A deep black round blotch at base of caudal fin between 22nd and 24th scales and another at the base of anterior dorsal ray.

Distribution: INDIA: Chatrickong river, Manipur valley; Pakistan; Bangladesh; Myanmar; Yunnan.

Remarks: *Puntius sophore* is very similar to *P. chola* but it can be easily distinguished from the latter as it has no barbels. The fish exhibits bright colouration with a reddish longitudinal band along the sides during the breeding season. It can be a good aquarium fish. Talwar and Jhingran (1991) reported that the fish matures at 7-8 cm in SL. The authors also reported that the species has medicinal value in Tamil Nadu. Vishwanath *et al.* (1998) reported it for the first time from Chatrickong and Lokchao rivers in Manipur.

Puntius stoliczkanus (Day)

Barbus mcClellandi Day, *Proc. Zool. Soc.* 1869, p. 619 (not Cuv. and Val.)

Barbus stoliczkanus Day, *Journal Asiatic Soc. Bengal*, 1871, pt. ii. p. 328.

Material examined: MUMF 3018/4., 48.5-51.4 mm SL, Lokchao R., Moreh. 24-26.iii.1999, WV & party, MUMF 3019/2., 43.1-50.6 mm SL, Litan stream., WV.

Local name: Phabou nga (Manipuri).

Diagnosis: A *Puntius* with no barbels, body comparatively deep, about 42% SL. Complete lateral line with 20-24 scales, 4 scales from lateral line to origin of dorsal and 4 from lateral line to anterior root of pelvic fin. Last unbranched dorsal ray osseous, serrated. A large spot at the caudal peduncle.

Colour: Body silvery, the spot at the caudal peduncle large and black.

Distribution: INDIA: Chindwin drainage, Manipur; MYANMAR: Putao.

Remarks: *P. stoliczkanus* is reported from the state of Manipur and from India for the first time in this paper.

Puntius ticto ticto (Hamilton-Buchanan)

Cyprinus ticto ticto Hamilton-Buchanan, 1822, *Fish. Ganges*: 314, 398, pl. 8, fig. 87 (type locality: south-east part of Bengal).

Material examined: MUMF 3030/1., 47.5 mm SL, Imphal valley, 19.viii.1998, JL.

Local name: Ngakha (Manipuri).

Diagnosis: This *Puntius* has a compressed body. Dorsal fin inserted nearer caudal fin base than the tip of the snout. Dorsal spine serrated posteriorly. Predorsal scales 10, circumpeduncular scales 11, pre-pelvic scales 14, pre-anal scales 20. Caudal fin forked. Barbels absent, lateral line incomplete. Perforated scales 7 anteriorly, 26 scales in lateral series and 11 on lateral transverse rows. Two black blotches, one near gill opening and another at the posterior portion of anal fin base. The latter blotch is found further forward than in all other *Puntius* species having two blotches. Anterior spot is always present.

Colour: Body silvery with two black blotches, one at the base of caudal fin and another at the edge of operculum. In freshly dead specimens, fins and flanks are reddish. The operculum is shot with golden red during the breeding season.

Distribution: Widely distributed in India, Bangladesh, Sri Lanka, Pakistan and Myanmar.

Remarks: Hora (1921) reported the fish to be the commonest *Puntius* in the Manipur Valley. Though small in size, it has high food value among the locals.

ACKNOWLEDGEMENT

The authors are grateful to the UGC-Special Assistance Programme and ICAR-NATP on freshwater fishes for financial assistance.

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Journal of the Bombay Natural History Society, 101 (1), Jan.-Apr. 2004 138-140

A NEW NEMACHEILINE FISH OF THE GENUS *SCHISTURA* McCLELLAND (CYPRINIFORMES: BALITORIDAE) FROM MANIPUR, INDIA[1]

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A new freshwater nemacheiline fish *Schistura macrocephalus* is described here based on 15 specimens collected from the Khuga river (Chindwin drainage) of Manipur, India. The species has a wide head and body with inflated cheeks and is distinct in having an adipose crest extending between dorsal and caudal fins, 8 branched dorsal fin rays, 15-16 dark transverse bars on body, incomplete lateral line.

Key words: Nemacheiline fish, *Schistura macrocephalus* sp. nov., Manipur

INTRODUCTION

Manipur state, in the northeastern corner of India, has numerous hill streams, the central plain and eastern part drained by the Chindwin drainage, and the western part by the Brahmaputra drainage. The state, thus, has a rich loach fauna. Chaudhuri (1912) described *Schistura manipurensis* from Ukhrul district. Hora (1921) described *S. kanjupkhulensis*, *S. prashadi*, *S. sikmaiensis* from the state. Hora (1937) while writing on a small collection of fish from the upper Chindwin drainage reported the occurrence of *S. vinciguerrae* in the Namya river at Kongan Thana, Kabo or Shan village, Myanmar. However, the place is now within the boundary of Manipur, India. Menon (1987) also reported the occurrence of *S. peguensis* in the State.

Khuga river originates in the hills of Churachandpur district of Manipur and flows northwards to join the Loktak Lake. A collection of fishes from the river included 15 specimens of *Schistura*, which do not fit into the hitherto described species of the genus. The fish is described here. Counts and measurements follow Kottelat (1990). Type specimens are deposited in the Manipur University Museum of Fishes (MUMF), Imphal, Manipur.

Schistura macrocephalus sp. nov.

(Figs 1-2)

Material examined: **Holotype**: MUMF 5013, 67.0 mm SL, Khuga R. in Churachandpur District, Manipur, 8.iv.2000. Coll. K. Shanta Devi.

Paratypes: MUMF 5001-5008, 8 exs, 60.0-88.3 mm SL, Khuga R. in Churachandpur district, Manipur, 20.iii.2000. Coll. K. Shanta Devi. MUMF 5009-5014, 6 exs, 62-69 mm SL, collection data same as holotype.

Diagnosis: A species with the following combination of characters: presence of adipose crest between dorsal and caudal fins, inflated cheeks and swollen anterior body part in males, upper lip without median incision, lower lip interrupted in the middle, presence of processus dentiformes, a median notch in lower jaw, branched dorsal fin rays 8, axillary pelvic lobe, incomplete lateral line.

Description: D. iii, 8; A. iii, 5; C. 9+8; P. i, 8; V. i, 6. Body elongate. Body slightly compressed posteriorly. Head depressed, snout broadly rounded and blunt. Anterior nostrils pierced in the front side of a flaplike tube, lower lip interrupted in the middle, processus dentiformes present. A median notch in lower jaw. Cheeks greatly inflated in males. Axillary pelvic lobe present. Pelvic fin origin under last simple or first branched dorsal rays. Distal margins of dorsal fin convex. Caudal fin emarginate. Dorsal adipose crest extends from posterior extremity of dorsal fin base to caudal origin. Lateral line incomplete, reaching at least to anal fin base. In males, it lies in thick skin, making it difficult to locate. Females have a distinct lateral line.

Sexual dimorphism: Male specimens have swollen anterior body, triangular head with greatly inflated cheeks. Lateral line indistinct due to thick skin.

Colour: Body with 15-16 dark bars on a dull brown background. Bars faintly marked regularly. Bars in front of dorsal fin conspicuously thinner than those behind, usually united in pairs at their upper extremity and less well marked, the bars are wider than interspaces and are well marked behind dorsal fin. Black bar at the base of caudal fin. Head brown, lighter on ventral surface. Black spot at base of simple rays to second branched dorsal rays, and second dark blotch at base of branched rays 2-8.

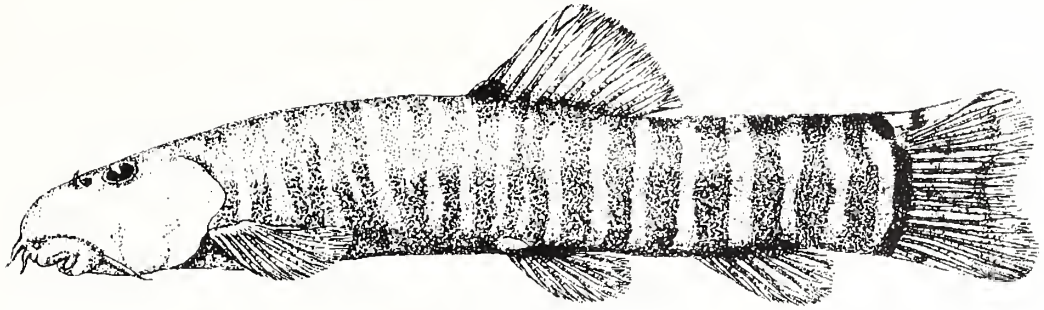

Fig. 1: *Schistura macrocephalus* sp. nov. (female)

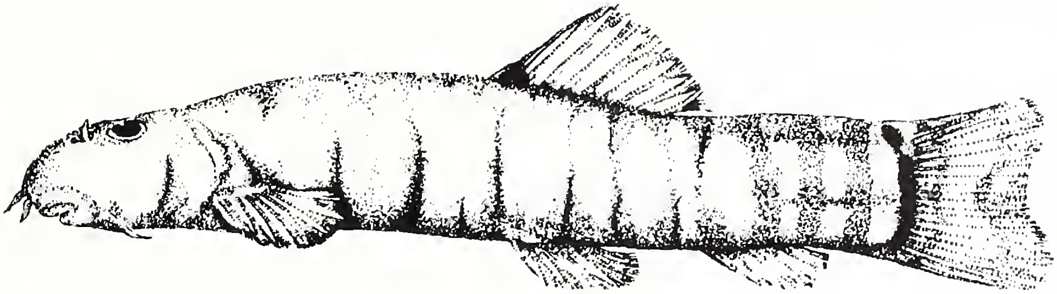

Fig. 2: *Schistura macrocephalus* sp. nov. (male)

Table 1: Comparison of Morphometric Characters of *Schistura macrocephalus* sp. nov. with *Schistura alticrista* (as % of SL, except TL and SL)

	Schistura macrocephalus sp. nov.			*Schistura alticrista*		
	mean	range	S.D.	mean	range	S.D.
Standard length		55.0-88.3			46.8-70.9	
Total length	119.0	117.6-123.9	1.62	119.2	117.8-120.7	1.33
Dorsal head length	20.2	16.9-25.4	2.15	22.2	22.0-22.7	0.33
Lateral head length	24.0	20.3-27.4	2.20	25.2	25.0-25.4	0.99
Predorsal length	52.2	50.0-55.8	1.48	51.8	50.9-52.4	0.61
Prepelvic length	55.6	53.3-58.5	1.63	52.6	51.3-54.5	1.38
Pre-anus length	73.3	69.3-58.5	1.66	71.8	70.5-72.6	0.91
Preanal length	79.3	76.9-82.3	1.65	76.2	74.7-77.1	1.07
Head depth (at eye)	12.4	10.2-13.4	1.11	11.0	9.8-11.8	0.85
Head depth (at nape)	13.5	11.2-14.7	1.09	12.6	12.3-13.1	0.36
Body depth	17.9	15.8-20.9	1.77	18.3	17.6-18.8	0.48
Depth of caudal peduncle	15.0	13.3-16.1	0.85	16.2	15.0-17.7	1.12
Length of caudal peduncle	13.1	10.9-14.6	1.11	14.4	13.9-15.0	0.45
Snout length	10.4	8.6-11.7	1.01	10.9	10.3-11.4	0.48
Head width (at nares)	13.6	10.4-17.7	2.17	10.8	9.2-11.6	1.13
Maximum head width	18.5	15.0-21.6	1.92	16.2	14.5-17.3	1.22
Body width (at dorsal origin)	17.5	15.5-20.2	1.75	11.6	11.3-12.1	0.39
Body width (at anal origin)	13.1	10.1-18.4	2.04	6.8	6.2-7.5	0.51
Eye diameter	3.9	3.1-4.8	0.50	4.5	4.2-4.7	0.18
Interorbital width	6.9	5.6-8.3	0.88	5.2	4.3-5.7	0.64
Height of dorsal fin	17.4	13.2-19.3	2.31	15.2	13.4-18.2	2.11
Length of upper caudal lobe	19.5	17.6-22.5	1.38	20.4	19.0-21.1	0.95
Length of lower caudal lobe	19.5	17.6-22.5	1.38	21.8	19.9-22.9	1.33
Length of median caudal rays	15.2	12.9-18.3	1.37	15.2	14.8-16.0	0.55
Depth of anal fin	13.8	11.0-16.6	1.38	17.6	16.8-18.4	0.65
Length of pelvic fin	15.1	13.4-16.9	1.07	17.2	16.8-17.7	0.41
Length of pectoral fin	16.2	13.4-18.3	1.30	20.0	19.2-20.5	0.61

Distribution: INDIA: Khuga river (Chindwin basin), Manipur.

Etymology: The species name is based on its large and broad head.

DISCUSSION

The species is similar to *Schistura alticrista* Kottelat (1990) from Nam Mae Yunnan basin, a tributary of Salween river in Thailand, in having adipose crest between dorsal and caudal fins. The new species, however, can be easily distinguished from *S. alticrista* in having fewer branched dorsal fin rays (8 vs. 9½); greater number of dark transverse bars on body (15-16 vs. 8-9); wider body [body width at dorsal origin 17.5 (15.5-20.2)% vs. 11.6 (11.3-12.1)% of SL; body width at anal origin 13.1(10.1-18.4%) vs. 6.8(6.2-7.5)% of SL].

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CEROPEGIA ANANTII (ASCLEPIADACEAE), A NEW SPECIES FROM WESTERN GHATS, INDIA[1]

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Ceropegia anantii Yadav, Sardesai and Gaikwad sp. nov., discovered from Salva Hill in Western Ghats (Sindhudurg District, Maharashtra State), is described with illustrations.

Key words: *Ceropegia anantii*, new species, Asclepiadaceae, Western Ghats

The genus *Ceropegia* L. (Asclepiadaceae) is represented in India by about 48 species (Jagtap and Singh 1999) of which 28 are endemic to the country (Ansari 1984; Ahmedullah and Nayar 1986; Jagtap and Singh 1999). Western Ghats is an important centre for diversification of *Ceropegia* and harbours about 35 species of which 22 are endemic to the region (Yadav 1996). The majority of the endemic species are restricted to small areas and some of them are known only from their type localities. Many of them are on the way to extinction. An interesting species of *Ceropegia* allied to *C. attenuata* L. was collected from Salva Hills in September 1998, which is described and illustrated here.

Ceropegia anantii Yadav, Sardesai and Gaikwad sp. nov.

Ceropegia attenuata proxime affinis sed corollae lobo ad basim utrinque atro-brunneus maculatus, corolla tubo anguste, ad basim abrupte ampliata et lucis fenestrum distincte differt. Typus: India, Maharashtra, ditionis Sindhudurg, Collinum Salva, Yadav-495A (Holotypus CAL), Yadav-495B (Isotypus K), Yadav-495C (Isotypus BSI), Yadav-495D (Isotypus Blatt.), Yadav-495E (Isotypus SUK).

Ceropegia anantii Yadav, Sardesai and Gaikwad sp. nov. is closely allied to *C. attenuata* L. but differs in having a dark brown spot on basal portion on either side of corolla lobe, narrow corolla tube with abruptly dilated basal part and distinctive light windows (Table 1).

Type: India, Maharashtra State, Sindhudurg district, Salva Hills, Yadav-495A (Holotype CAL), Yadav-495B (Isotype K), Yadav-495C (Isotype BSI), Yadav-495D (Isotype Blatt.), Yadav-495E (Isotype SUK).

Perennial erect herb. Rootstock tuberous, tubers 2-3 cm in diameter, depressed, roots fibrous. Stem sparingly hairy, terete, usually unbranched, 15-40 cm in height, 1-2 mm in diameter. Leaves opposite, subsessile, minutely puberulous, linear, 4-8 x 0.3-0.5 cm, acute at apex, tapering at base, scabrous on upper surface, glabrous on lower surface except the midrib, margins minutely hairy. Flowers solitary, axillary or extra axillary; pedicel 4-6 x 0.6-0.8 mm, pubescent; bracts solitary, attached a little above the middle of pedicel, linear, 2.3-2.6 x 0.3-0.4 mm, acute. Sepals 5-7 x 0.7-0.8 mm, linear, subacute, pubescent. Corolla 4-6.5 cm long, straight, greenish-yellow; corolla tube 1-2.5 cm long, abruptly dilated at the base, glabrous, greenish outside, the lower inflated portion dark purple in throat and striated with purple lines in lower portion; corolla lobes up to 1.3-3.5 cm long, connate at tips, forming a long beak, greenish-white, pubescent inside, each lobe with dark spot on either side in basal part of corolla lobe. Gynostegial corona cupular, consisting of 5 deeply bifid lobes, densely ciliate on the margins; staminal corona of 5 linear lobes, connivent, erect, 4-5 mm long. Pollen masses yellow, attached to the brown pollen carriers by short caudicles, each pollinarium 0.3-0.35 x 0.2-0.25 mm. Follicles single or double, up to 6-7 x 0.2-0.25 cm, straight, tapering to a fine point, erect. Seeds 4 x 1.5 mm, ovate, oblong; coma 1-1.5 cm long, white, silky.

Fl. & Fr.: August-November.

Local Name: Ghayal.

Distribution: Restricted to flat tops of Salva Hills in Sindhudurg district of Maharashtra State. About 300 individuals were located in September 1998.

Etymology: The species is named after Prof. Anant R. Kulkarni, Mumbai for his valuable contribution to botany, especially angiosperm systematics.

Ceropegia anantii Yadav, Sardesai and Gaikwad sp. nov. is closely allied to *C. attenuata* L. but differs in the following characters (Figs 1-2):

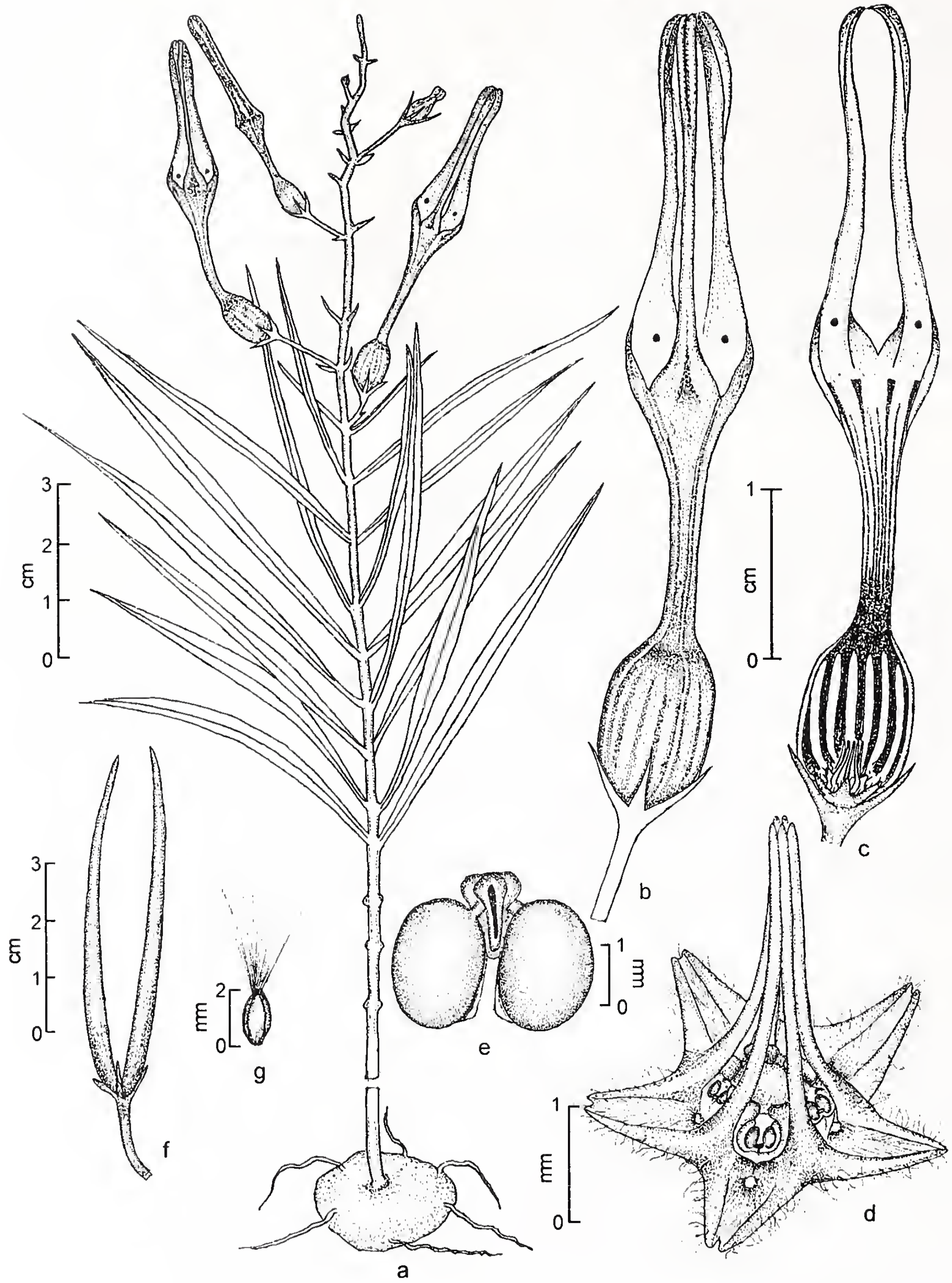

Fig. 1: *Ceropegia anantii* Yadav, Sardesai and Gaikwad sp. nov., a. Habit, b. Flower, c. L.S. of flower showing light windows, d. Corona, e. Pollinarium, f. Follicles, g. Seed with coma

Table 1: Differences in characters in *Ceropegia anantii* and *Ceropegia attenuata*

S. No.	*Ceropegia anantii* Yadav, Sardesai and Gaikwad sp. nov.	*Ceropegia attenuata* L.
1.	Grows on plateaus at higher altitudes	Grows on coastal plains of lateritic plateaus at lower altitudes
2.	Leaves narrowly linear	Leaves linear to lanceolate
3.	Narrow corolla tube abruptly dilated at base	Corolla tube gradually dilated at base
4.	Dilated corolla tube with brown rim in upper portion	Dilated corolla tube without brown rim in upper portion
5.	Corolla tube with dark brown spot on basal portion on either side of corolla lobe	Corolla tube without dark brown spots
6.	Corolla lobes cohering from base to apex	Corolla lobes free except at apex

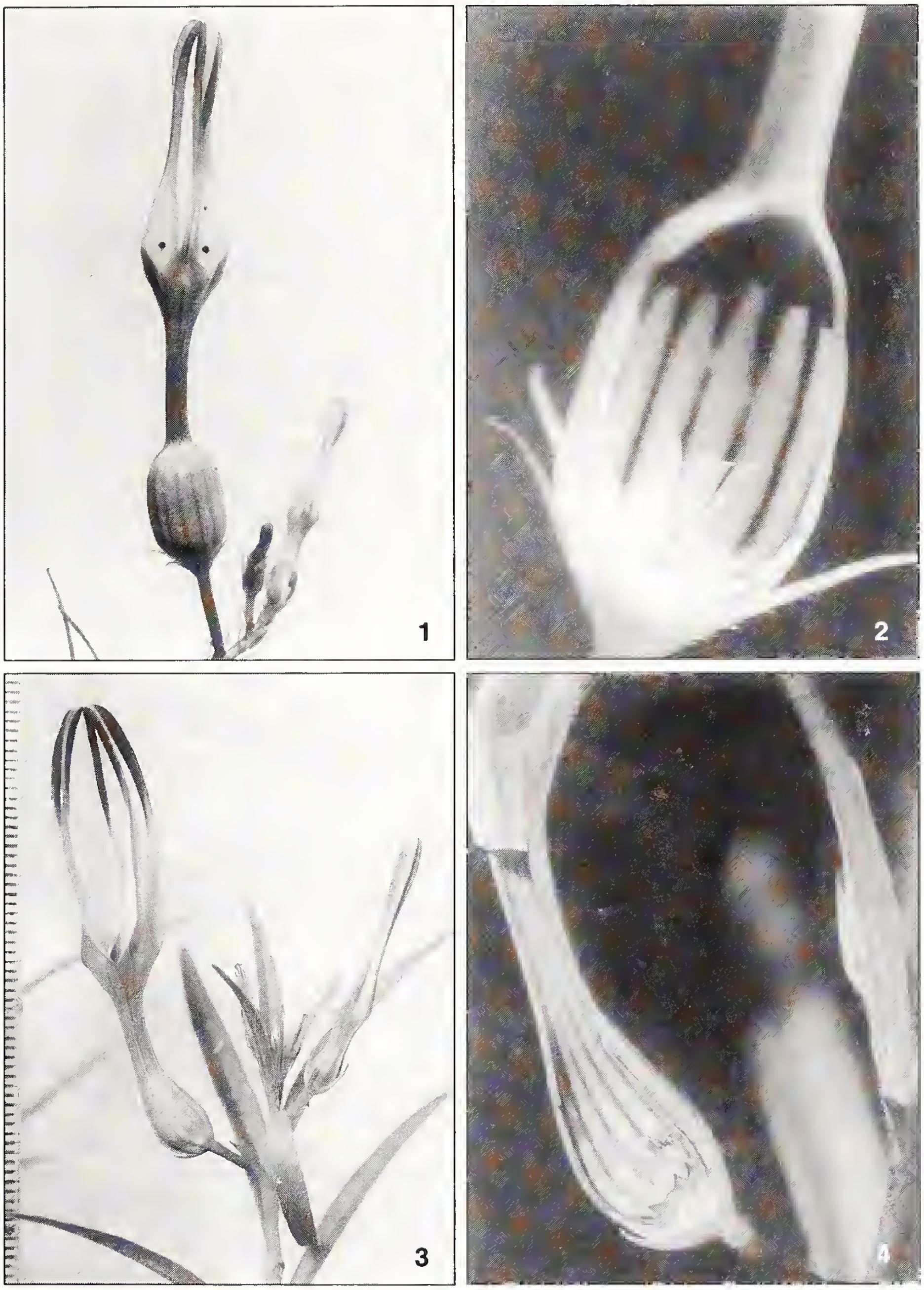

Fig. 2: *Ceropegia anantii* Yadav, Sardesai and Gaikwad sp. nov., 1. Flowers, 2. L.S. of flower showing light windows; *Ceropegia attenuata* Hook., 3. Flower, 4. L.S. of flower showing light windows

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REVIEWS

1. FLORA OF THE DISTRICT GARHWAL, NORTHWEST HIMALAYA (WITH ETHNOBOTANICAL NOTES) By R.D. Gaur. Pp. xvi + 811 (28 x 21.5 cm). Published by TransMedia, Srinagar (Garhwal), India, 1999. Price Rs. 1600/- ($ 100).

This is a valuable book on flowering plants of the Garhwal Himalaya written by an expert. The book includes 2,035 species belonging to 978 genera and 189 families, one of them being described for the first time. The book is based on the classification proposed by Cronquist, with a few modifications, in contrast to most of our Indian Floras that are based on Bentham and Hooker's classification, according to which the major herbaria in India are arranged. It contains keys to families, genera and species, and under the text of each species mentions: 1. The correct name of the species with the basionym and important synonyms, 2. Common names, 3. Short descriptions, 4. Phenology, 5. Relative abundance, 6. Range of Distribution, 7. Number of voucher specimen deposited in the Garhwal University Herbarium and 8. Ethnobotanical uses.

The introduction gives 1. Geographic features, 2. Climate, 3. Inhabitants: People and wildlife, 4. Vegetation analysis, 5. Cultigens and aliens, 6. Dynamics of vegetation, 7. List of rare and threatened plants, 8. Short history of previous explorations, 9. Methodology and 10. Statistical analysis of the Flora.

This is a very useful study as the only other work on this region is the FLORA OF CHAMOLI by B.D. Naithani (Vols I & II, 1984-85). However, like the earlier work, this volume also has no illustrations.

In the list of 164 rare and 47 endangered species are listed 16 rare plants, which are not so rare in other parts of the country, and four of the species listed as endangered are found in abundance in southern India.

The floristic analysis mentions 10 dominant families, of which Poaceae (78 spp.), Asteraceae (73 spp.), Leguminosae (72 spp.), Lamiaceae (33 spp.), Orchidaceae (28 spp.), and Rubiaceae (25 spp.) are noteworthy.

The author has updated the nomenclature, as far as possible, as per the ICBN rules. However, a fresh look at the following nomenclatural cases and some explanations are warranted (see Table).

I would also like to make the following comments:

1. *Tinospora cordifolia* (Willd.) Hook. f. & Thoms.: The correct name for this species is *T. glabra* (Burm. f.) Merrill.

2. *Cannabis sativa* Linn.: The high alkaloid containing Indian plant is considered as the subspecies *indica* in comparison with the fibre-yielding non-alkaloidal typical subspecies of the West.

3. *Cardamine scutata* Thunb. ssp. *flexuosa* (Withering) Hara: Hara's varietal name seems to have priority over Withering's and the name of the author in parenthesis may be an error.

4. *Moringa oleifera* Lamk. is nomen illegitimatum on account of its carrying an earlier synonym when it was first published, making the name applicable to that taxon.

5. *Symplocos cochinchinensis* ssp. *laurina* (Retz.) Nooteboom var. *laurina*: Nomenclature of this taxon has been mauled and muddled. *Myrtus laurinus* Retz. (1789) cited in synonymy has priority over *Dicalyx cochinchinensis* Lour. (1790) and therefore the specific epithet *laurina* cannot be reduced to an infraspecific taxon under *cochinchinensis*.

Page	Name accepted	Prior name available
101	*Parietaria micrantha* Ledeb. (1829)	*P. debilis* Forst. f. (1786)
	Quercus leucotrichophora A. Camus (1835)	*Q. incana* Roxb. (1832)
	Alternanthera pungens H.B.K. (1817)	*A. repens* (L.) Link (Based on *Achyranthes repens* L. 1753)
	Persicaria tenella (Bl.) Hara var. *kavagoeana* (Makino) Hara	*Polygonum tenella* Bl. (1825)
	Grewia optiva Drum. ex Burret (1926)	*G. oppositifolia* Buch.-Ham. (1825)
	Abelmoschus manihot (L.) Medik. ssp. *tetraphyllus* (Roxb.) Borss.	*Hibiscus manihot* Linn. (1753)
	Casearia elliptica Willd. (1800)	*Anavigna lanceolata* Lamk. (1783)
	Lagerstroemia reginae Roxb. (1795)	*L. speciosa* (L.) Pers.
	Hydrocortyle nepalensis Hook. (1823)	*H. javanica* Thunb. (1798)
	Holarrhena pubescens (Buch.-Ham) Wall. (Based on name of 1821)	*Echites antidysenterica* Roxb. ex Fleming (1810)
	Eusteralis cruciata (Benth.) Panigrahi (Based on name of 1830).	*Mentha quadrifolia* D. Don (1825)

6. *Brassica rapa* L. ssp. *campestris* (L.) Clapham.: If *B. rapa* L. and *B. campestris* L. are considered distinct at sub-species level, then *B. campestris* L. ssp. *rapa* Hook.f & Anders (1872) has priority over *B. rapa* L. ssp. *campestris* (L.) Clapham (1962).

7. *Embelia tsjarium-cottam* (R. & S.) A. DC. is nomen dubium, which is not properly typified yet and may belong to some other plant. The correct name for the species known under this name is *E. basal* (R. & S.) A. DC. (see Almeida, Fl. Maharashtra, Vol. 3).

8. *Balliospermum montanum* (Willd.) Muell.-Arg. has been changed to *B. solanifolium* (Burm.f.) Suresh (see Nicolson *et al.*, Interpret. Hort. Mal. P. 1988).

9. The species known as *Bridelia retusa* (L.) Spr. in our Indian Floras is now called *B. airy-shawii*, for which the correct name may be *B. spinosa* Willd.

10. Correct name for *Buchanania lanzen* Spr. is *B. cochinchinensis* (Lour.) Almeida (see Fl. Maharashtra, Vol. 1).

11. Correct name for *Coleus forskohlii* (Willd.) Briquet is *Solenocarpus barbatus* (Andr.) Codd. *Solenopteris* Thonn. is the earliest generic name for *Coleus* Lour., if treated as a separate genus from *Plectranthus* L'Herit.

12. Nomenclature of *Artemisia nilagirica* var. *septentrionalis* (Clarke) Panigrahi has been confused by adding *A. vulgaris* var. *nilagirica* Clarke to its synonymy.

13. *Amorphophallus paeoniifolius* Nicolson is not synonymous with *A. campanulatus* Blume ex Decne as presumed initially by Nicolson. Sivadasan later reduced *A. campanulatus* Blume to the varietal rank under *A. paeoniifolius* (Dennst.) Nicolson, which also remains doubtful.

14. Rechecking is required for the nomenclature of *Arisaema tortuosum* (Wall.) Schott and its variety *curvatum* (Roxb.) Engler. From the synonyms cited, it appears that what is referred to as variety *curvatum* may be a typical variety and that which is referred to as *A. tortuosum* var. *tortuosum* may have to be correctly called *A. tortuosum* var. *helleborifolium* (Schott.) Engler as done by Nair (1978).

15. The correct generic name for *Indocourtosia* Bennet & Raizada is *Courtosinia* Sojak and that for *Indocourtosia cyperoides* (Roxb) Bennet & Raizada is *Courtosinia cyperoides* (Roxb.) comb. nov.

Regarding the price of the book, I would only like to state that a book that is priced at more than a rupee per page of printed matter is over-priced, unless it is illustrated with colour photographs, which naturally increases the cost of printing.

M.R. ALMEIDA

2. THE FLORA OF THE PALNI HILLS (in 3 parts): Pt I (Polypetalae) pp. xcvi + 1-576; Pt II (Gamopetalae and Monochlamydae) pp. iii + 576-1196; Pt III (Monocotyledones) pp. iii + 1197-1880 (26 x 20 cm) by K.M. Matthew. Published for Rapinat Herbarium at SCTP Offset Press, Christianpet, Vellore, India, 1999. Price (set of 3) Rs. 600/ £ 100/ $ 175.

This Flora, consisting of three parts, is the second phase covering the montane counterpart of FLORA OF TAMILNADU, the first phase being FLORA OF TAMILNADU CARNATIC, covering the lowlands. The total work done over a quarter of a century from 1976 to 1999, has resulted in the publication of twelve volumes. This Flora describes about 2,500 species based on about 15,000 fresh herbarium collections spread over 323 days of fieldwork.

In the third part of this Flora, the author has taken the help of two other taxonomists to revise some families, namely Gunnar Seidenfaden for Orchidaceae and K.T. Mathew for Juncaceae, Eriocaulaceae, Cyperaceae, Graminae and Gymnospermae.

Rev. Fr. K.M. Matthew, after trying his hand at revision of Family Cornaceae for FLORA MALESIANA with a ZWO fellowship from the Dutch Government at The Rijksherbarium, Leiden, Netherlands, returned to India in 1974 and prepared a scheme for the revision of the comprehensive illustrated FLORA OF TAMIL NADU. Since then, he has collected more than 50,000 herbarium specimens. When he started the work on FLORA OF TAMIL NADU CARNATIC, Fr. Mathew felt that the days of general plant collection were over and the era of monographic work had begun. But over a period of time, he has not only begun to believe in the value of fresh collections, but is proud of his freshly collected herbarium. He admits that he has rightly opted for floristic work, leaving the monographic, which some of his colleagues at Leiden wanted him to pursue. One thing is certain, Rev. Fr Matthew has shown that with dedication you can accomplish much, despite limited assistance.

However, at the conclusion of FLORA OF PALNI HILLS, his achievements are one new combination *Chamaecrista kleinii* (Hook.f.) K.M. Matthew at species level and two new combinations at the intraspecific level, namely *Commiphora caudata* (Wt.

& Arn.) Engler var. *pubescens* (Wt. & Arn.) K.M. Matthew and *Solanum violaceum* Ortega ssp. *multiflorum* (C.B. Clarke) Matthew. He depends too much on the opinions of other experts and cannot form an independent opinion, and that is why he has left the identities of many taxa undecided, although he has come close to identification of their allies.

The text of the Flora, after keys to families (according to Bentham and Hooker's system of classification), genera and species, is in the following format:

1. Correct botanical name of the species, followed by basionym and synonyms, followed by local and English names.
2. Description of species.
3. Distribution and altitudes of occurrence.
4. Phenology.
5. Phytogeography.
6. Exsiccata.
7. Conservation notes.

The following appendices appear at the end of Part III:

I. Cultivated species of the Palni hills.
II. Field itineraries on Palni hills.
III. Alphabetical list of books referred to in the Flora.
IV. Alphabetical list of periodicals referred to in the Flora
V. Journals in the herbarium (RHT) library.
VI. Germination data of native species (255 spp.).

Appendix VI may be the most attractive among the Appendices. I wonder if Appendices III and IV are lists of the books and periodicals referred to, or books and periodicals cited in the Volume.

In many cases, however, all the heads mentioned above are not strictly adhered to. In Part I, for example, there are 788 species. Of these, 143 have no data on phenology. Plants not described number 257, and many have merely one or two lines of description (probably because they have been described in FLORA OF TAMIL NADU CARNATIC earlier, for which the reference is given, making it mandatory to have that Flora at hand while using this one).

Many species are included based on Anglande's unedited drawings, which are cited in references. Such species are not described. There is no evidence that the figures Anglande made are from plants collected from Palni hills or brought from other localities. Examples of such plates are *Lonicera caprifolium* L. (t. 281), *Lonicera etruca* Santi (t. 282), and *Lonicera periclymenum* L. (t. 286).

The following species are based on specimens at Kew and other places, not on recent collections, and one would believe that Matthew has extensively surveyed the area, and they are presumably locally extinct:

1. *Lasianthgus stigilobus* Hook.
2. *Blumea hieracifolia* var. *macrostachya* (DC.) Hook.f.
3. *Carpesium cernuum* L.
4. *Pratia nummularia* (Lamk.) Braun & Aschers
5. *Rhododendron policum* L.
6. *Tylophora macrantha* Hook.f
7. *Tylophora pauciflora* W. & A.
8. *Argyreia pilosa* Arn.
9. *Barleria longifolia* L.
10. *Acrocephalus palniensis* Mukherjee
11. *Emex spinosus* (L.) Compel.
12. *Dendrophthoe memecylifolia* (W. & A.) Danser
13. *Delechampia indica* Wt.
14. *Eriocaulon melaleucum* Mart.
15. *Cyperus elatus* L.
16. *Fimbristylis bisumbellata* (Forsk.) Bubani
17. *Fimbristylis eragrostis* (Nees) Hance
18. *Fimbristylis squarrosa* Vahl
19. *Liphocarpha sphacellata* (Vahl) Kunth
20. *Mariscus cyperoides* A. Dietr.

As mentioned earlier, Matthew relies heavily on help from other botanists without verifying the nomenclature himself and following his own judgement. I would cite an example here of *Tylophora tetrapetala* (Dennst.) Suresh in Nicolson *et al.*, which is a wrong and illegitimate name. Many Indian works, which have brought nomenclatural changes as per ICBN rules are not noticed or neglected. For example, Ramamurthy (in Fl. Hassan Dist. p. 340, 1976) equates *Excoecaria robusta* Hook.f with *E. crenulata* Wight, which is overlooked in the Flora. In the note under *Drypetes roxburghii* (Wall.) Hurusawa, Dr. Matthew states, "The case of retaining this species under the genus *Putranjiva* (Etym.: Life of the son), owing to its fertility properties, is strong." This note was uncalled for. Matthew accepted Bowles and Stearn's reduction of *Atragene japonica* Thunb. (1784) to a varietal rank under *Anemone hupehensis* Lemoire ex Boynton (1931), without explaining why Thunberg's prior name could not be accepted as *Anemone japonica* (Thunb.) Almeida (comb. nov.). *Hibiscus furcatus* Willd. (1809) has been placed in synonymy of *Hibiscus hispidissimus* Griffith (1854) without assigning any reason. In Pinaceae, in Gymnospermae, which has been revised by both K.M. Matthew and K.T. Mathew following two synonyms, as per citations, seem to have come from the same publication. Which one of them has come from the reference cited I leave to the readers to find out:

Pinus kesia Royle ex Gordon in Loudon, Gard. Mag. (London) 16: 8, 1840.

Pinus khasya Royle, Gard. Mag. (London) 16: 8, 1840.

K.T. Mathew seems to be not in the habit of citing basionyms and synonyms if he can avoid them. One has the feeling that he is sure about his accepted name and does not think there is any scope for further nomenclatural correction. However, in the few places where he has cited the synonyms he is in troubled waters, as in the case of *Scirpus quinquangularis* Vahl, *Cyperus uniloides* R. Br. and *Scirpus michelianus* Linn. Under *Carex lindleyana* Nees ex Wt. (1834) he has given two more varieties. Additional varieties are provided with segregating key, while the typical variety has been left out. It appears from the exsiccata cited under typical and the note at the end of infraspecific taxa that the typical variety is a distinct variety from the other two and it cannot be fitted in the key given to the other two.

As already mentioned, Orchidaceae has been revised by Gunnar Seidenfaden. I am surprised to find some confusion in nomenclature in his part of the work too. Under *Brachycorythis iantha* (Wt.) Summerh. (which is based on *Platanthera iantha* Wt. (1851) there are three names highlighted in bold type in the synonymy along with *Platanthera obcordata* Lindl. (Gen. & Sp. Orchid. Pl. 290, 1835). If we consider the bold lettered synonyms a typographical error, the correct name for this species should be *Brachycorythis obcordata* (Lindl.) comb. nov. which I propose here. At the end of the test of this species, Seidenfaden mentions the type (of the species?) as specimens from Nilgiris (Wight, s.n., K, BM). I believe that types pertain to a name and not to a species. There has to be a type for each name. If there are five heterotypic synonyms there should be five different types. *Platanthera iantha* must have a type. If there are two specimens of this species, one at Kew (K) and another at the British Museum (BM), one of them can be a Holotype (or Lectotype) and other may be called Isotype or Paratype (or Syntype). Similarly, *Platanthera affinis* Wt. must have a separate type; *P. galeandra* Rech.f must have yet another type and *Platanthera obcordata* Lindl. may be typified by Wallich Cat. no. 7050A or 7050B and *Habenaria galeandra* Benth. var. *nilagirica* Hook.f must have a different type.

Under *Peristylis exilis* Wight, Seidenfaden cites contrasting synonyms as mentioned below:

Habenaria aristata (Lindl.) Hook.f.

Peristylis aristatus auct. non Lindl.

Seidenfaden also accepts *Habenaria virens* (Lindl.) Hunt & Summerhayes when there is an existing homonym by Abywickrama. His argument that Hunt and Summerhayes did not mention *Habenaria virens* (Lindl.) Abyw. (1959), possibly because Abywickrama's transfer was considered invalid due to wrong citation of basionym, is not appropriate in this case because the later homonym of Hunt and Summerhayes cannot be validated as per ICBN rules. The name *Seidenfia rheedii* (Sw.) Szlachetko is based on *Malaxis rheedii* Sw., which is supposed to have included *Epidendrum resupinatum* in the synonymy which renders Swart's name illegitimate. Therefore, the next available valid name for this species is *Microstylis versicolor* Lindl. (Gen. & Sp. Orchid. Pl. 21, 1830) and the correct name for this species should be *Seidenfia versicolor* (Lindl.) Almeida (comb. nov.).

The price of the book Rs. 600 is at least half the market value today (not quarter as claimed by author). I congratulate Rev. Fr. Matthew for successfully completing his plan and compliment him for undertaking the publishing work and providing his Floras to researchers and scientific communities at such low rates.

M.R. ALMEIDA

3. MEDICINAL PLANTS IN ANDHRA PRADESH (INDIA) by T. Pullaiah. Pp. iii + 262 (23.0 x 15.5 cm). Published by Regency Publishers (20/36 – G, Old Market, West Patel Nagar, New Delhi 110 008). Price Rs. 700/-.

This book lists 409 species of medicinal plants found in Andhra Pradesh, arranged in alphabetical order of scientific plant names. The author's un-named and undated preface mainly describes the location of Andhra Pradesh, with three lines of explanation regarding the arrangement of entries of the species in the book and acknowledgement of the author to his wife for help in preparation of the manuscript. It gives 121 line drawings of species listed and 14 plates consisting of 68 coloured photographs of medicinal plants. The text gives accepted names of species (occasionally with a few synonyms), family to which the species belongs, short description (3-5 lines), occurrence and distribution, flowering and fruiting seasons, propagation by seed or cuttings, and medicinal uses, which are reproduced from earlier published literature.

The book cites 17 bibliographic references, followed by 12 names of companies dealing in the medicinal plant trade. One of them, Nicolas Piramal India Ltd, denied the statement when contacted by the reviewer for confirmation. Many of the plant names in the book are outdated and the book has several wrong names of medicinal plants based on wrong identification.

One species has been listed under two different synonyms, *Cascabela thevetia* (L.) Lippold (p. 66) and under *Thevetia peruviana* (L.) Merr. (p. 238). The description and uses mentioned under the conspecific names are quite different.

Under *Embelia tsjarium-cottam* DC. the medicinal uses mentioned are similar to *Embelia ribes* and the seeds are used as substitute for that species. This is certainly a wrong and confused statement. It has been now conclusively shown that the plant so far known as *Embelia tsjarium-cottam* is actually *Embelia basaal* (R. & S.) A. DC. and the seeds of this species are sold under the name *E. ribes*. It is yet to be confirmed that seeds of *E. ribes* Burm.f. also contain Embelin, an antihelminthic principle found in *Embelia basaal* (R. & S.) A. DC.

Indigofera tinctoria L. and *I. sumatrana* Gaertn. have been equated. However, the two plants are believed to be distinct species, *I. sumatrana* Gaertn. contains a toxic compound that causes itching and irritation when handled with bare hands while isolating blue dye.

Under *Moringa pterigosperma* Gaertn. after *Moringa oleifera*, auct. non Lamk. is cited. Actually *M. oleifera* Lamk. is an illegitimate synonym of *M. pterygosperma* Gaertn. The name is illegitimate because Lamark, in the original publication, cited another binomial under his name making the name applicable to a different species cited by him under the new name.

The book does not have indexes, and plants known by their synonyms cannot be located. It has line drawings and a few photographs of plants, but is not comparable in text and price with the Glossary of Indian Medicinal Plants, which gives well documented information and is much cheaper.

M.R. ALMEIDA

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4. MEDICINAL PLANTS IN INDIA. Vols. I & II. by T. Pullaiah. Pp. iii + 861 (23.0 x 15.5 cm). Published by Regency Publishers (20/36 – G, Old Market, West Patel Nagar, New Delhi 110 008). Price Rs. 1,500/- (set of 2).

The four page Introduction gives information on Vedic period and Ayurveda, concluding with information on the herbal market. According to the author, there are 17,500 angiosperms in India, 7,500 of them are medicinal and 950 are with new claims made through recent research. Looking at these figures, one can imagine that the number of Indian medicinal plants dealt with (580) are comparatively few. The text is arranged in the same manner as in the author's MEDICINAL PLANTS IN ANDHRA PRADESH, that is in alphabetical order of scientific names of the plants, and gives secondary information gathered from old sources of literature, of which there is a bibliography. Information in the book is also in the same pattern as MEDICINAL PLANTS IN ANDHRA PRADESH and 409 plants listed are reproduced along with 68 additional diagrams. This book also has several outdated names.

Mussaenda frondosa L. is a species from Sri Lanka and occurs in India only under cultivation as an ornamental. The wild native plant, which goes under this name, is *M. glabra* Hutchinson.

Justicia procumbens L. (p. 320) and *Rostellularia procumbens* (L.) Nees (447), and *Anthocephalus chinensis* (Lamk.) A. Rich ex Walp. (p. 62) and *Neolamarkia cadamba* (Roxb.) Bosser (p. 377), found under two entries are one and the same species.

Marsilea quadrifolia L. (p. 348) is only reported from Kashmir in India. The common *Marsilea* species with wider distribution and containing the active principle Marsilin causing paralysis of nervous system is *Marsilea minuta* Linn.

The line drawing given as *Phyllanthus amarus* is certainly not of that species. It may be *P. urinaria* Linn. Similarly, the commonly used "Aritha" or "Ritha" is *Sapindus trifoliatus* Linn. (syn. *Sapindus laurifolius* Vahl) not *S. emarginatus* Vahl.

The list of herbal drug manufacturers has gone up to 79 in this book, and it concludes with two indexes — Index to the Sanskrit names and Index to the trade names. The lists are in alphabetical order, but there is no index to botanical synonyms used in the text and therefore the names known under earlier synonyms cannot be located.

There are 22 colour plates of 99 photographs and 186 line drawings, covering 861 species of medicinal plants. The price at Rs. 1500/- is not justifiable by any standard.

M.R. ALMEIDA

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MISCELLANEOUS NOTES

1. SIGHTING OF CARACAL IN THE CHAMBAL RAVINES OF BHIND DISTRICT, MADHYA PRADESH

While surveying the Bhind district of Madhya Pradesh, to capture crop-raiding Nilgai, for translocation to the Kuno Wildlife Sanctuary (as part of a prey base supplementation for the proposed Asiatic Lion Reintroduction Project), I saw two Caracals (*Caracal caracal*) at an interval of about 15 days. The first sighting was on March 26, 2001 at 1630 hrs while I was standing on a hillock in the ravines. The Caracal was stalking and its tufted ears were conspicuous. The second sighting was on April 11, 2001 at 1930 hrs while I was coming back from the ravines and a Caracal came right in front of the vehicle. A few faculty members of the Wildlife Institute of India and the DFO, Kuno Wildlife Sanctuary, also saw it.

The study area included five villages, namely Bijpuri, Lavan, Chandupura, Karke ka pura and Gopalpura. The area surrounding these villages (2-4 sq. km) is privately owned, i.e. revenue land, and is being used for agriculture. The entire area has ravines.

The major plant species are *Prosopis cineraria*, *Capparis decidua*, *C. sepiaria*, *C. zeylanica*, *Acacia leucophloea*, *A. nilotica*, *Azadirachta indica*, *Salvadora oleoides*, *Balanites aegyptiaca*, *Zizyphus mauritiana* and *Z. nummularia* (Khudsar *et al.* 2001). The area has diverse fauna, such as the Caracal, Pangolin (*Manis crassicaudata*), Small Indian Civet (*Viverricula indica*), Indian Porcupine (*Hystrix indica*), Wolf (*Canis lupus*), Jackal (*Canis aureus*), Hedgehog, Chinkara (*Gazella bennetii*), Nilgai (*Boselaphus tragocamelus*), Hare and many species of birds.

After observing many bird kills, especially dove and partridge, and also scats with bird feathers, I asked the villagers of Bijpuri about the presence of the Caracal, locally called *Seyahgosh*, by showing a photograph. They confirmed its presence and informed that it mostly stayed in porcupine burrows. Prater (1971) also suggested that Caracals keep their kittens in porcupine burrows. They become more visible during the monsoon; perhaps they are not able to stay in the burrow.

Caracal is an endangered small cat, listed in CITES Appendix-I (Nowell and Jackson 1996), and in Schedule I of the Wildlife (Protection) Act 1972.

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2. OCCURRENCE OF INDIAN WOLF *CANIS LUPUS PALLIPES* IN THE PENCH TIGER RESERVE, MADHYA PRADESH

In December 1997, we were moving around the Pench Tiger Reserve at sunset, when a herd of cattle to the right of our vehicle panicked and ran towards us. To our surprise, we saw three wolves chasing the cattle. The wolves were startled when our vehicle halted with a screech. The first animal was a male, larger than the other two following it. They stood for a minute and moved away to the nearby *Cleistanthus* forest. We got down to follow the wolves, but they disappeared quickly into the forest. Though we had heard about the presence of wolves near the villages around the Pench Tiger Reserve, this was our first sighting.

After this incident, there were no sightings by the villagers until the afternoon of March 23, 1999 when two wolves were reported seen close to Bodki village, 8 km from the Tiger Reserve. The wolves were stalking goats grazing close to a crop field, as we watched from our vehicle from a distance of *c.* 100 m. The wolves felt our presence and ran away towards the forest. We followed them for about 15 minutes along the road, as they moved ahead of our vehicle. We were fortunate to get the animals on video for a few minutes. Again, on April 29, 1999, the villagers of Karmajhiri reported that a pack of wolves had lifted five goats from their village in the morning. One goat had managed to escape and the half eaten carcasses of the other four were left near the village field.

Playfair (1891) reported the destruction of human life by wolves in the Hoshangabad and Narsinghpur districts of Madhya Pradesh. Shahi (1982) reported the presence of wolves in six districts of Madhya Pradesh. After 13 years, Bharos (1996) reported their presence in Rewa, while Ranjitsinh (1998) reported the sighting of a female wolf in Raisen and Sidhi districts. In the same year, K. Yoganand of Wildlife Institute of India reported the presence of wolves and sighting of their scats and tracks on the fringes of Panna National Park, Panna district, Madhya Pradesh. This is the first report from Seoni district.

In Pench Tiger Reserve, Wild Dogs or Dholes (*Cuon alpinus*) are observed to occupy the forest, while wolves remain on the fringes, close to human settlements. The Pench Tiger Reserve supports major Carnivora, such as Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Indian Jackal (*Canis aureus*), Wild Dog, Indian Wolf (*Canis lupus*), Indian Fox (*Vulpes bengalensis*) and Striped Hyena (*Hyaena hyaena*).

The Indian Wolf seems to be widely distributed in Madhya Pradesh. The presence of wolves in Pench Tiger Reserve poses an intriguing question as the forest area is occupied by other canids, like the Wild Dog and Indian Jackal, which are common. Yoganand and Johnsingh (2000) have also reported the co-existence of Dhole and Wolf in Panna, based on temporal and spatial segregation, wherein the Wolf occupies the forest fringes and the Wild Dog the forested area.

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3. DEATH OF A BLUE BULL *BOSELAPHUS TRAGOCAMELUS* DUE TO SNAKEBITE

Gura Bishnoi is a protected area covering 422 sq. km of area, *c.* 15 km southeast of Jodhpur (26° 78' N, 73° 08' E). There are 24 villages in this protected area, of which some are predominantly Bishnoi community areas.

On the morning of September 9, 2001, I visited Khajarli, the place where a legendary group of Bishnois died trying to protect the Khejri (*Prosopis cineraria*). On the way, we stopped at Khajarli pond to observe Chinkara *Gazella bennetti*, Blackbuck *Antilope cervicapra* and a variety of birds. We were standing on the bank of the pond and watching wildlife when we heard an unusual animal sound in the nearby *Prosopis juliflora* plantation. We rushed in the direction of the sound, and saw a 1.5-1.8 m long Indian cobra (*Naja naja*) crossing the path. Further, there was a male Blue Bull *Boselaphus tragocamelus* on a crippled hind leg, which prevented it from walking or running properly. After 10-12 minutes, the animal began to tremble and fell to the ground. People working in the fields nearby also came to the spot. One of the old Bishnoi farmers looked at the male Blue Bull and said that it was another case of snakebite by the black snake usually seen in the area. The Blue Bull's mouth was foaming with saliva and its left leg was swollen, when it finally died an hour later.

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4. BARKING DEER *MUNTIACUS MUNTJAK* IN MUNDANTHURAI, TAMIL NADU

A note by Ray *et al.* (2000) states that the authors saw Barking Deer once in Deer Valley, and twice in Kadayam, that Barking Deer had apparently moved into Deer Valley from Kadayam and are new additions to the fauna of the Mundanthurai Sanctuary.

Barking Deer is a common nocturnal of the Deer Valley. When I was Warden, Mundanthurai, I named the area Deer Valley, as four deer species, i.e. Spotted Deer, Sambar, Barking Deer and Mouse Deer were seen there.

The Forest Working Plans of Lasrado, Rajasingh and Wilson refer to Barking Deer. J. Wilson writes about the long tongue of the Barking Deer. Besides, old shooting records, a wildlife map of Mundanthurai by M.A. Badshah, and the Tiger Reserve Proposal to the Government of India by Saroj Raj Choudhry mention this deer's presence in the area. Choudhry (1984) did a pellet group sampling of Deer Valley.

In 1973, T. Jeyadev, Chief Conservator, on seeing the footprints and droppings of barking deer in a fenced and failed sandalwood plot in Koiltheri in his field inspection notes wrote succinctly, "We, however, have nice neem plants, thanks to the Barking Deer". Sandal was raised with neem as hosts; Barking Deer nibbled off sandal seedlings, leaving the neem plants alone (Jeyadev 1973).

I had taken Dr. Krishnaswamy with Dr. Murali Chandrasekaran to Kannikatty Forest Rest house in 1977. We had seen a Barking Deer, the darker variety, opposite a *Gluta travancorica* sample plot established in 1914. Dr. Krishnaswamy has recorded this in the Forest Rest House book (Entry for 1997).

Barking deer is not a new addition to the fauna of the Sanctuary. It was always there. While the excitement of seeing an animal for the first time in the wild is understandable, authors are advised to refrain from rushing to hurried conclusions, like this imaginary mammalian movement.

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5. MORTALITY OF WILD ANIMALS IN ROAD ACCIDENTS IN KUMBHALGARH WILDLIFE SANCTUARY, RAJASTHAN, INDIA

Kumbhalgarh Wildlife Sanctuary is spread over 585 sq. km, and lies between 20° 5' - 23° 3' N, and 73° 15' - 73° 45' E, *c.* 200 km south of Jodhpur in the west Aravalli hills of Rajasthan, India (Fig. 1). The altitude varies from *c.* 274 to 849 m above msl. The Sanctuary is characterized by a distinct winter, summer and monsoon. During summer, the temperature fluctuates between 30 and 35 °C, and may reach 46 °C during May and June. The mean winter temperature is 5 °C; it may go down to 2 °C during December-January. Average annual rainfall is recorded as 725 mm, while the minimum is 403 mm and maximum is 950 mm.

The forest is mainly dry deciduous or woodland type, dominated by gorya dhawa (*Anogeissus latifolia*), salar (*Boswellia serrata*), gol (*Lannea coromandelica*), kherni (*Wrightia tinctoria*), dhawa (*Anogeissus pendula*), kumbat (*Acacia senegal*), khair (*Acacia catechu*), ber (*Zizyphus mauritiana*), and dhak (*Butea monosperma*). The undergrowth mainly consists of jharber (*Zizyphus nummularia*), adusa (*Adhatoda zeylanica*), gangan (*Grewia tenex*), franger (*Grewia flavescens*), kanter (*Capparis sepiaria*), and lantana. Some climbers and grasses are also found.

The main fauna of the Sanctuary includes Leopard (*Panthera pardus*), Hyena (*Hyaena hyaena*), Wolf (*Canis lupus*), Jackal (*Canis aureus*), Sloth Bear (*Melursus ursinus*), Four-horned Antelope (*Tetracerus quadricornis*), Chinkara (*Gazella bennettii*), Porcupine (*Hystrix indica*), Sambar (*Cervus unicolor)*, Blue Bull (*Boselaphus tragocamelus*), Common Palm Civet (*Paradoxurus hermaphroditus*), Jungle Cat (*Felis chaus*), Fox (*Vulpes bengalensis*), Crocodile (*Crocodylus palustris*) and Rock Python (*Python molurus*).

Road kill data was collected during a long-term study on the eco-behavioural diversity of the Hanuman

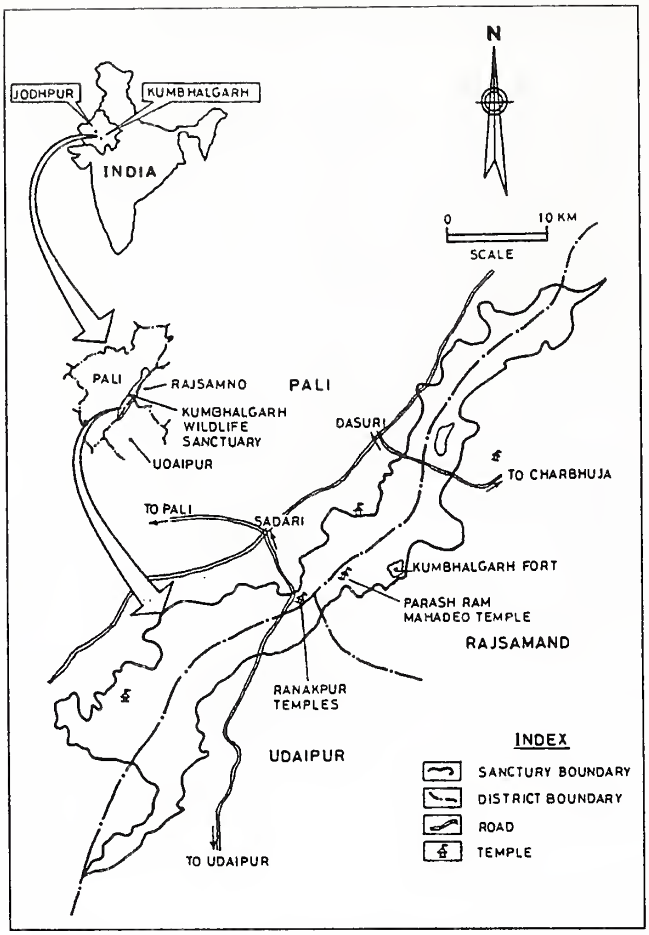

Fig. 1: Location of Kumbhalgarh Wildlife Sanctuary in the Aravalli Hills

Langur (*Semnopithecus entellus*) in and around Kumbhalgarh Wildlife Sanctuary. Two state highways (about 25 km long) and 3 ancillary roads (30 km long) pass through the Sanctuary. Between December 1995 and August 1999, while driving on the highway to and from the study area, the location and species of each road kill was recorded. Occasionally, road kills were also reported by forest officials and drivers. This information was verified and included in the study. The recording efforts remained more or less constant throughout the study. Road kills generally disappeared from the road within a few hours to a day, with scavengers operating in the area. This study is limited to larger animals, like mammals, birds and reptiles, though frog and invertebrate kills were common. During the tourist season and monsoon, the number of road accidents was high. To estimate the percent mortality, the monthly road kills were calculated from the data collected during December 1995 to December 1998.

A total of 374 road kills (Table 1) were observed and recorded in and around Kumbhalgarh Wildlife Sanctuary. Of these, 80% occurred on highways. They were common along sharp turns, slopes, near water holes and on small tracks, which were preferred by animals for crossing roads. Altogether 43 species of animals were found killed in road accidents. Of these, 49% were birds, 39.5% were mammals and 11.5% were reptiles. The most common victim was the Hanuman langur, followed by the common palm civet and squirrel (*Funambulus pennanti*).

Doves and babblers were the common bird species in the road kills (Table 1). Of the total reptile kills, the Checkered Keelback (*Xenochrophis piscator*) was the main victim.

Maximum road kills (13.9%) were observed in August during monsoon and minimum (3.2%) in June during summer. Fewer road kills were recorded between January and July (Fig. 2).

Some vehicle - animal collisions also involve material damage and human casualties. Nine collisions between vehicles and blue bull were recorded during this study. In several accidents, the drivers successfully avoided hitting an animal, but in the process lost control of the vehicle. On an average, one animal collision occurred every month on the roads in and around the Sanctuary. Deliberate killing of animals by drivers was also recorded.

The most commonly killed mammals were nocturnal species, like common palm civet and jackal. Wild boar and blue bull usually got killed in the evenings when they crossed the road, as they moved out of the Sanctuary to raid crop fields (Chhangani and Mohnot 1997).

Home ranges of the study troops of Hanuman Langur cross over the highway located in our study area. Road accidents have also been observed in other study sites by Mohnot (1974), Rajpurohit (1987), Agoramoorthy (1987), Chhangani and Mohnot (1997), and Rajpurohit and Chhangani (1997).

Large numbers of Hanuman Langur are killed in road accidents. Of the total langurs killed, about 25% were victims of road accidents (Chhangani 2000). The world famous Ranakpur temple is visited by a large number of tourists, who offer food to langurs, which keep close to the temple (Chhangani 2000). The langurs expect food from every passing vehicle, so they do not give way to speeding vehicles, and are killed by them. Provisioning of langurs along the roads is common due to religious sentiments. Many times, during fights and other interactions between bisexual troops and all-male bands, these animals while running and chasing each other suddenly come in front of a vehicle, get hit and often die instantaneously.

Langurs also use the roads for walking, running and foraging for vegetation along the roadside. Besides,

Table 1: Animal kills recorded in road accidents in Kumbhalgarh Wildlife Sanctuary from December 1995 to 1998

Common name	Scientific Name	Nos. Killed
MAMMALS		
1. Leopard	*Panthera pardus*	2
2. Hyena	*Hyaena hyaena*	1
3. Jackal	*Canis aureus*	12
4. Blue Bull	*Boselaphus tragocamelus*	6
5. Wild Boar	*Sus scrofa*	3
6. Wolf	*Canis lupus*	1
7. Fox	*Vulpes bengalensis*	5
8. Common Palm Civet	*Paradoxurus hermaphroditus*	24
9. Jungle Cat	*Felis chaus*	6
10. Hanuman Langur	*Semnopithecus entellus*	29
11. Common Mongoose	*Herpestes edwardsi*	4
12. Small Indian Mongoose	*Herpestes javanicus*	5
13. Squirrel	*Funambulus pennanti*	20
14. Indian Gerbil	*Tatera indica*	10
15. Field Mouse	*Mus platythrix*	14
16. Indian Hare	*Lepus nigricollis*	5
17. House Mouse	*Mus musculus*	8
Total		155
BIRDS		
1. Long-billed Vulture	*Gyps indicus*	4
2. Indian White-backed Vulture	*Gyps bengalensis*	7
3. Grey Francolin	*Francolinus pondicerianus*	9
4. Common Quail	*Coturnix coturnix*	6
5. Rock Bush-quail	*Perdicula argoondah*	2
6. Grey Junglefowl	*Gallus sonneratii*	5
7. Indian Peafowl	*Pavo cristatus*	6
8. Blue Rock Pigeon	*Columba livia*	5
9. Indian Ring Dove	*Streptopelia decaocto*	16
10. Red Collared-dove	*Streptopelia tranquebarica*	8
11. Little Brown Dove	*Streptopelia senegalensis*	12
12. Greater Coucal	*Centropus sinensis*	6
13. Common Indian Nightjar	*Caprimulgus asiaticus*	2
14. Common Myna	*Acridotheres tristis*	3
15. House Crow	*Corvus splendens*	9
16. Jungle Crow	*Corvus macrorhynchos*	2
17. Common Babbler	*Turdoides caudatus*	14
18. Jungle Babbler	*Turdoides striatus*	6
19. Pied Bush-chat	*Saxicola caprata*	8
20. Indian Robin	*Saxicoloides fulicata*	2
21. House Sparrow	*Passer domesticus*	12
Total		144
REPTILES		
1. Common Indian Monitor	*Varanus bengalensis*	25
2. Monitor (unidentified)	*Varanus* sp.	4
3. Indian Cobra	*Naja naja*	5
4. Cat Snake	*Boiga trigonata*	12
5. Checkered Keelback	*Xenochrophis piscator*	29
Total		75

these busy roads help them to avoid predators, like the Panther, Wolf and Jackal that usually avoid coming on the roads in the day.

Amongst birds, doves and babblers were the worst affected (38% of total kills) as they usually feed on the road. They are attracted to the seeds and grains that fall from transport vehicles, and dead insects and ants crushed on the roads during monsoon. Birds are run over or hit when taking off suddenly. A large proportion (16%) of birds killed were vultures and crows. These scavengers get hit while feeding on dead animals on the road. Among the reptiles, the Checkered Keelback are most affected. They are killed in the monsoon mostly on roads and near water holes, because of their amphibious habit (R.C. Sharma pers. comm.). The road kill problems of Kumbhalgarh Wildlife Sanctuary are similar to those in Spain and in African protected areas (Lopez 1993, Lopez and Roviralta 1993, Broekhuysen 1965, Lewis 1989, Drews 1991).

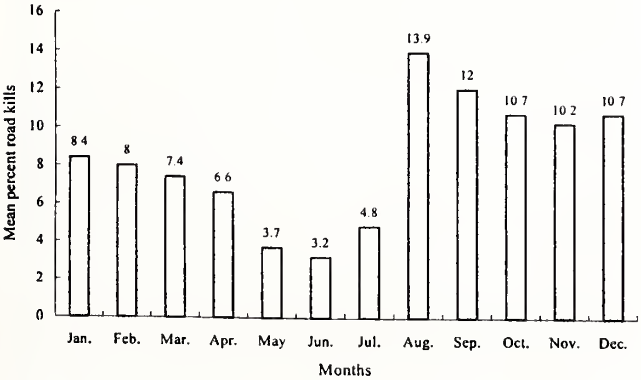

Fig. 2: Percent road kills in different months in and around Kumbhalgarh Wildlife Sanctuary (Dec. 1995 to Dec. 1998)

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6. GREATER SPOTTED EAGLE *AQUILA CLANGA* PALLAS AND NORTHERN SHOVELLER *ANAS CLYPEATA* LINN. — TWO RARE RECORDS FROM KERALA

On January 11, 2001, while conducting the waterfowl census at the Kattampally wetlands near Kannur, a Greater Spotted Eagle *Aquila clanga* was seen. The raptor was observed for almost one hour, in good light, as it soared overhead. It was a dark brown bird having broad wings with splayed out primaries, underwing-coverts darker than the flight feathers, white spots on the upperwing forming a thin wingbar and white uppertail-coverts. These features suggested that the bird was an immature. The author is familiar with this species with many sightings at Bharatpur. Kattampally is one of the major wetlands of Kerala and hosts large congregations of migratory and resident water-fowl. On November 20, 1998, the author along with N.K. Satyan had seen a soaring *Aquila* eagle being mobbed by a Brahminy Kite *Haliastur indus*, but specific identification was not possible as the raptor was too far away.

The only published record of the Greater Spotted Eagle in Kerala is a single undated sighting by Srivastava *et al.* (1995), quoted by BirdLife International (2001).

At Kattampally, on March 27, 2001, 4 male Northern Shovellers *Anas clypeata* were spotted by P.C. Rajeevan and the author among a group of more than 500 Garganey *Anas querquedula* and Northern Pintail *Anas acuta*.

An early record of this species from Kerala is that of a specimen received by A.O. Hume from Wynaad (Kinnear and Whistler 1930).

April 2, 2002

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7. MARSH HARRIER *CIRCUS AERUGINOSUS* PRE-ROOSTING ON TREES IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

The Keoladeo National Park (27° 7.6' to 27° 12.2' N, 77° 29.5' to 77° 33.2' E) in Rajasthan is a known roost of Marsh Harriers (Samant *et al.* 1995). During the present study (1997-99) more than 150 Marsh Harriers were recorded roosting in the grasslands of the Park.

The harriers roost communally on the ground outside the breeding season (Newton 1979). The Marsh Harriers were observed roosting communally in the southeast corner of the Park on the ground among tall grasses in Block-G (locally called Koladehar). They started arriving at the roost area about an hour before sunset and pre-roosted on trees lining the roost area. This behaviour is unusual, as they have never been recorded pre-roosting on trees elsewhere. They generally pre-roost on bare ground before settling in the actual roosting site (Clarke 1996, Donald 1905).

By pre-roosting in the open, harriers probably attract their roosting allies to a particular roost to increase the roost size, as has been seen in other species (Zahavi 1971). Roosting communally in big flocks has its own advantages (Ward and Zahavi 1973). Pre-roosting on tree-tops by Marsh Harriers in the Park may be for the same reason, as the grass here is very tall (about 2.5 m). Pre-roosting on the ground would not be beneficial, as they would not be visible to their conspecifics. Another possible reason for pre-roosting on trees could be to avoid the mammalian predators lurking around, such as the Jungle Cat *Felis chaus*, Jackal *Canis aureus*, and Striped Hyena *Hyaena hyaena*, that are frequently sighted in the grassland.

During the winters of 1997-98 and 1998-99, 74% of the pre-roosting (n = 3753) was recorded on trees.

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8. BLUE-WINGED PARAKEET *PSITTACULA COLUMBOIDES*, FAMILY PSITTACIDAE, FEEDING ON *LORANTHUS* LEAVES

On March 5, 2001, I was birding near Doodha Sagar in Mahaveer Wildlife Sanctuary, Goa when I saw a Blue-winged Parakeet (*Psittacula columboides*) and Indian Hanging-parrot (*Loriculus vernalis*) on an Arjuna tree (*Terminalia arjuna*).

On close observation, I found that both the species were feeding on the green leaves of a parasitic plant on the Arjuna tree. The half chewed leaves were collected and later identified as *Loranthus longiflorus*. On March 6, 2001, the same activity was observed in Castle Rock village on the Goa - Karnataka border, Joyda taluka, Uttar Kannada district, Karnataka.

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9. SIGHTING OF THE ORIENTAL BAY-OWL *PHODILUS BADIUS SATURATUS* IN PAKHUI WILDLIFE SANCTUARY, WESTERN ARUNACHAL PRADESH

The Oriental Bay-Owl (*Phodilus badius*) has been considered a rare resident throughout its range in the Indian subcontinent, which consists of three disjunct areas (Ali and Ripley 1983, Hussain and Khan 1997). While there have been several recent records of the southern subspecies *assimilis* from the Anaimalai Hills and the Kalakkad-Mundanthurai Tiger Reserve, southern India (Kannan 1993, Mudappa 1998, Raman 2001), there have been no recent reports of the subspecies *saturatus* from either north-east India, or from western Arunachal Pradesh.

I sighted an individual of the Oriental Bay-Owl in Seijusa in Pakhui Wildlife Sanctuary (WS) on January 18, 1999. Pakhui WS is located in western Arunachal Pradesh, near the Assam-Arunachal Pradesh border, and covers an area of 862 sq. km, with an altitudinal variation from 100 to 2,000 m. The major vegetation type of Pakhui WS is tropical semi-evergreen forest. There are adjacent tracts of intact forest areas, logged forests, plantations and agricultural settlements. Extensive loss of forest cover and degradation has occurred mainly in some areas in adjacent Assam. Around 267 bird species have been recorded from this area, and six other species of owls have been reported (Datta *et al.* 1998). The main threats to the existence of these forests are logging and settlements, hunting. Minor disturbances are extraction of cane, agar (*Aquillaria agallocha*), and other minor forest produce.

The owl was sighted at an altitude of *c.* 300 m, which was *c.* 500 m from the Forest Department Range offices and 50 m from a frequently used forest trail. Locals and forest staff often move through the area to cut firewood and poles for construction, and to collect food and medicinal plants, mushrooms and black dammar (*Canarium resiniferum*).

I first spotted the owl at 0815 hrs and watched it for the next half hour. It was facing me with closed eyes, perched on a horizontal branch of a small understorey tree *c.* 5 m from the ground. As the species was unfamiliar to me, I sketched and photographed it (Fig. 1). It seemed quite unperturbed, though we were standing and watching it from such close quarters. It remained motionless for half an hour. The owl opened its eyes once or twice, but otherwise ignored our presence. Interestingly, earlier daytime sightings of this bird have reported that it could be observed for quite some time, because it did not fly away immediately on being disturbed (Kannan 1993, Mudappa 1998).

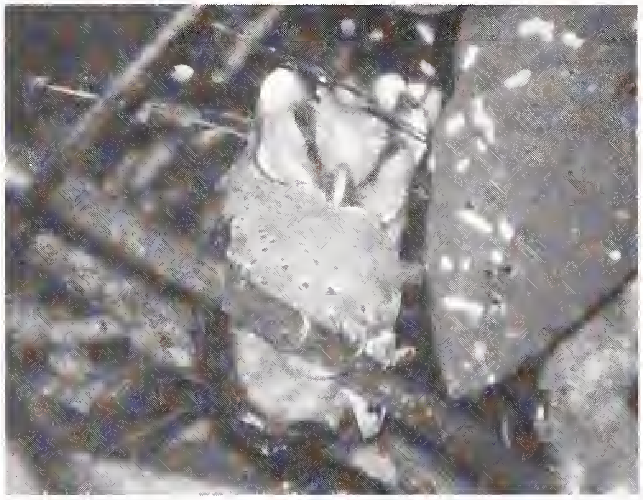

Fig. 1: Oriental bay-owl perched on an understorey tree in Pakhui Wildlife Sanctuary, Arunachal Pradesh

The Bay-Owl seems rare and ranges from foothill forests up to 1,500 m in NE India. The subspecies *saturatus* is reported from Nepal, Sikkim, Nagaland, Manipur, and Assam, north and south of the Brahmaputra river (Ali and Ripley 1983), and also South-East Asia. However, the present observation is the first record for Arunachal Pradesh.

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10. ALBINISM IN WHITE-BREASTED KINGFISHER *HALCYON SMYRNENSIS* (LINNÉ) FROM INDIA

On August 7, 1999, my attention was drawn towards a white bird that flew past our speeding jeep between Sambajiguda and Jamini villages in Jainur mandal, Adilabad district of Andhra Pradesh, north of Kawal Wildlife Sanctuary (19° 05'-19° 20' N and 78° 32'-79° 12' E). A thorough search of the area resulted in the sighting of an albino White-breasted Kingfisher *Halcyon smyrnensis* (Linné) that was observed from 1218 to 1226 hrs. It was frequently chasing another individual of the same species with loud cackling calls. The birds remained in the vicinity of a small stream flowing between fallow fields and scrub. Alarmed at being followed constantly, the birds flew towards a nearby hillock where they could not be located. Photographs taken are not of printable quality, but fortunately the bird was successfully videographed.

Albinism among avians is not an uncommon feature and has been reported for many species earlier (Pittie, A. pers. comm.). Albinism in White-breasted Kingfisher has been reported from Sri Lanka (Gunawardana 1993) and Keoladeo National Park, Bharatpur (Rahmani, A.R. pers. comm.). This is the second report of the same from India.

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11. DUETTING CALLS OF THE HEART-SPOTTED WOODPECKERS *HEMICIRCUS CANENTE* (LESSON)

The various calls of the Heart-spotted Woodpecker (*Hemicircus canente*) have been summarized by Short (1982), and Ali and Ripley (1983). In both these standard references, there is no mention of a duetting call-note, which I have heard frequently during my study of woodpeckers at the Peechi-Vazhani Wildlife Sanctuary in Kerala. Both these works mention a "twee twee twee" call-note (originally described by Betts 1934), which is sometimes "extended into a trill of seven or eight notes." Short (1982) has interpreted this call as being equivalent to the aggressive trill call of the related Gray and Buff Woodpecker (*H. concretus*), which is found in Southeast Asia. This call of *H. concretus* contains a series of fast-repeated "pit" call-notes. He also commented that the "twee twee twee" call-note is similar to the thin, plaintive "su-sie", a call given with a short bow, repeated up to 10-12 times.

I would describe the "twee twee twee" notes referred to by Betts as the "duetting" notes and these are quite different from the "su-sie" call-notes. During my study at Peechi (1991-1993), I have recorded the duetting calls on at least 32 different dates. These calls are a fast repeated series of "twee twee twee", quite loud and sharp, and audible at fairly considerable distances from the birds (*c.* 200-250 m). These duets go on for anything between 5-6 seconds to about a minute, non-stop. Often, both birds of the pair are present next to one another or are within a few metres of each other when the calls are uttered. Most often, the calls are given from a perch, but they are also occasionally heard when one of the birds flies to join its mate from a nearby tree or branch. I have seen duetting birds often sitting next to one another. The birds assume an upright posture with their wings slightly drooped and often face each other while calling.

Duetting calls were heard mostly between September and December (59%), and rarely after February (13%). I have heard the birds duet near their nests. On one occasion, a male which came to relieve its incubating mate, called from a nearby tree. The female promptly responded by flying out of the nest-hole, and they duetted for 5-6 seconds. After this, the male entered the nest-hole and the female flew away.

In contrast, the “su-sie” calls are uttered even when the birds are alone and they are accompanied by bows and cocking the head. Though several such calls are repeated, this is done slowly, one at a time with an interval of one or two seconds each.

In my opinion, the duetting calls of the heart-spotted woodpecker could serve two purposes: the first, as a recognition call, perhaps also to maintain the pair bond, and second, being loud and sharp, as a territorial call. This species, as well as the related Gray and Buff Woodpecker, are known to drum uncommonly (Short 1982). I too heard the Heart-spotted Woodpecker drumming only on two occasions in the entire study period of 18 months. The drumming was weak and rather inaudible. The duet calls may act as a substitute for the drumming and may serve to announce the occupation of a territory.

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12. WOODPECKER HOLES USED FOR NESTING BY SECONDARY CAVITY-NESTERS IN THE WESTERN GHATS, INDIA

The use of woodpecker holes by secondary cavity-nesting birds is well known (Short 1979). Yet no specific information exists for the Western Ghats, India. During a study of woodpeckers at the Peechi-Vazhani Wildlife Sanctuary, Kerala, I came across eight species of secondary cavity-nesting birds using old holes of five woodpecker species (Table 1).

There was a close relation between the size (weight) of the bird and the diameter of the nest hole entrance. All the birds weighing more than 100 gm nested in the nest-holes of the Greater Golden-backed Woodpecker, whose mean nest-hole diameter was 12.7 cm, while the smallest bird (Yellow-throated Sparrow) nested more frequently in the nest-cavities of the Brown-capped Pygmy Woodpecker. This choice may be related to competition. Birds nesting in large cavities stand a greater chance of eviction by a larger competitor.

In addition, bees were seen occupying two nests of the Greater Golden-backed Woodpecker and one of the Lesser Golden-backed Woodpecker. Yellow-throated

Table 1: Details of secondary cavity-nesters occupying woodpecker nests

	Woodpecker species				
Secondary cavity-nesters	MG (12.7)* n = 19	SB (7.4)* n = 6	YN (6.8)* n = 3	MA (4.7)* n = 9	PY (3.4)* n = 10
Indian Roller (*Coracias benghalensis*) (169 gm)**	2	-	-	-	-
Spotted Owlet (*Athene brama*) (114 gm)**	1	-	-	-	-
Common Myna (*Acridotheres tristis*) (110 gm)**	3	-	-	-	-
Rose-ringed Parakeet (*Psittacula krameri*) (104 gm)**	1	-	-	-	-
Jungle Myna (*Acridotheres fuscus*) (83 gm)**	-	1	-	-	-
Grey-headed Starling (*Sturnus malabaricus*) (40 gm)**	-	-	1	-	-
Oriental Magpie Robin (*Copsychus saularis*) (35 gm)**	-	1	-	-	-
Yellow-throated Sparrow (*Petronia xanthocollis*) (18 gm)**	-	-	-	1	4

MG = *Chrysocolaptes lucidus* (Greater Golden-backed Woodpecker), SB = *Picus xanthopygaeus* (Little Scaly-bellied Green Woodpecker), YN = *Picus chlorolophus* (Small Yellow-naped Woodpecker), MA = *Dendrocopos mahrattensis* (Yellow-fronted Pied Woodpecker), PY = *Dendrocopos nanus* (Brown-capped Pygmy Woodpecker), *Nest entrance diameter estimate in cm (Santharam 1995), **Body-weight of the bird (Ali and Ripley 1983).

Sparrows were the most aggressive and persistent competitors. They attempted to evict Brown-capped Pygmy Woodpeckers even before the latter completed their nesting, and in one instance before the excavation was complete. In most cases, nest-holes were almost immediately occupied (within a week) after the woodpeckers vacated nests. There was a demand for fresh holes because these are safer, harbouring fewer parasites and known to fewer competitors and predators (Short 1979, Van Balen *et al.* 1982, Sedgwick and Knopf 1992).

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13. SIGHTING OF BLACK-NAPED ORIOLE *ORIOLUS CHINENSIS* AND FRANKLIN'S PRINIA *PRINIA HODGSONII* IN SIRKALI, NAGAPATTINAM DISTRICT, TAMIL NADU

Between January 26 and February 10, 2000, we carried out a survey of birds around villages in Sirkali taluka, Nagapattinam district, in the state of Tamil Nadu, south India. The habitats surveyed included wooded areas along rivers, grasslands, paddy fields, freshwater lakes, and coastal swamps. The villages are located along the Bay of Bengal coast, which is a major migratory route for birds leading to Point Calimere and onwards to Sri Lanka. We recorded a total of 113 species of birds, and two species, the Black-naped Oriole (*Oriolus chinensis*) and Franklin's Prinia (*Prinia hodgsonii*), were recorded for the first time from this area. The Black-naped Oriole was seen in a wooded area at a farm in Thittai village. It appears to be a rare winter visitor to India (Grimmett *et al.* 1999). Ali (1996) states that this species is an occasional winter visitor to the Peninsula, northeast India and Bangladesh. The Franklin's Prinia was very vocal as it rested on top of a bent grass blade in the paddy fields at sunset. The dark grey hood was almost like the Sardinian Warbler *Sylvia melanocephala*, and it contrasted markedly with the white belly unbarred by a grey breast-band. Its fantail was bordered with white spots disposed in scale. This species has not been seen in the area (Grimmett *et al.* 1999) and there is no mention of it in Ali (1996).

November 12, 2001

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14. RED-VENTED BULBUL *PYCNONOTUS CAFER* FEEDING BLACK DRONGO *DICRURUS MACROCERCUS* CHICKS

On a monsoon visit to the Panna Tiger Reserve in Madhya Pradesh, India between July 4 and 15, 2001 we were amazed at the number of bird species nesting in a half acre patch around our research camp, near the Hinauta entrance barrier. Among those feeding their nestlings at that time were Indian Rollers (*Coracias* *benghalensis*), Eurasian Golden Orioles (*Oriolus oriolus*), Black-headed Cuckoo-shrikes (*Coracina melanoptera*), White-browed Fantail-flycatchers (*Rhipidura aureola*), Red-vented Bulbuls (*Pycnonotus cafer*) and Black Drongos (*Dicrurus macrocercus*). Yellow-eyed Babblers (*Chrysomma sinense*) were building a nest, and by July 14 three eggs had been laid. Rufous-backed Shrikes (*Lanius schach*) were also around, feeding chicks that had recently left their nest.

This patch contained approximately thirteen large and small Teak trees (*Tectona grandis*), eight *Lagerstroemia parviflora* trees, three *Diospyros melanoxylon* and one *Terminalia alata*, besides a few *Zizyphus* and *Lagerstroemia* bushes. The Rollers were nesting in a cavity in the *Terminalia*, the Orioles had hung their basket nest on the lower branches of the largest of the *Diospyros* and the Babbler was weaving its cone in a small *Zizyphus* bush. The others chose the shelter of two of the *Lagerstroemia* for their nest - the Fantail-flycatcher, Bulbul and Cuckoo-shrike shared the same 10 m high tree in ascending order, and the Drongo was in another similar sized tree, *c*. 20 m away. Ali and Ripley (COMPACT HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Oxford University Press, New Delhi, 1987) say that some species, including orioles and bulbuls, "commonly build in the same tree as holds a Black Drongo's nest" as the latter is particularly forceful in its protection from other species. Perhaps this accounts for what seemed to be a relatively high density of nests in such a small patch. The White-browed Fantail-flycatcher is also a pugnacious defender of its territory.

Exact dates of hatching of the chicks are not recorded. By July 4, the Roller, Drongo and Oriole were all feeding chicks. The roller's chicks could not be seen and the adults proved too shy to watch closely. The Oriole's three chicks were still small and unfeathered, but the Drongo's three were already partially fledged. The fantails were first seen feeding on July 9 and the three chicks had probably only recently hatched.

The Cuckoo-shrikes' nest was spotted on July 11, although the adults had been seen carrying food a few days earlier. The bulbuls were first seen feeding only on July 15, and it seemed likely that these chicks were also recently hatched.

The Black Drongos were nesting at the fork of a branch approximately 4 m from the ground. Although I had been watching the nest off and on since my arrival and even spent time photographing them, I only saw the Bulbul come to the Drongo nest in the early morning of July 8. I cannot say for sure that it began on this day, as I was watching opportunistically and could possibly have missed it earlier. But the Drongo parents - both were feeding the chicks - were aggressive in chasing the Bulbul off when it came near the nest. The Bulbul developed a strategy of waiting nearby until both Drongo parents had fed their chicks, and then slipping in unobtrusively before they returned with the next food supply. Its arrival at the nest would herald a round of begging and it would feed a Drongo chick. On this first day, I also saw the Bulbul chase off the Yellow-eyed Babbler that was moving close to the nest tree. The Bulbul continued to feed the Drongo chicks every day after this, and we were able to photograph and film it doing so. By the evening of July 9, the two larger Drongo chicks were outside the nest and hopping along the branch; on July 10 these two were moving among the upper and lower branches of the tree, although all three were in or next to the nest by evening. The Bulbul continued to partake in the feeding. By midday of July 11, the third chick had also left the nest and from July 12 onwards, all three had left the nest tree and were moving in the neighbouring Teak trees which afforded them more cover — also from the rain. The Bulbul continued to bring food and feed them and the chicks continued to beg when they saw it nearby. The Drongo parents appeared to have got used to this arrangement too, and I saw no more aggression directed towards the Bulbul by them. Indeed, on July 12 evening, two of the chicks were sitting fairly close together and I saw one of the Drongo adults and the Bulbul on either side, hardly two feet apart, feeding almost simultaneously. The Bulbul was still following the three Drongo chicks around (by now there was no doubt of their parentage) and feeding them when we departed on July 15.

August 9, 2001

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15. REDISCOVERY OF THE YELLOW-THROATED BULBUL *PYCNONOTUS XANTHOLAEMUS* IN THE ANAIMALAI HILLS, WESTERN GHATS, SOUTH INDIA

The Yellow-throated Bulbul (*Pycnonotus xantholaemus*) is uncommon and patchily distributed in South India (Grimmett *et al.* 1998, Ali and Ripley 1971). The species is classified as vulnerable because of extensive removal of its prime habitat, fuelwood extraction and quarrying (BirdLife International 2000, Collar *et al.* 1994).

In the Anaimalai Hills, the Yellow-throated Bulbul was reported once by the Pollachi-Valparai road, just above Aliyar Dam (Kannan 1992), but could not be found again in subsequent searches (Kannan 1998). Whistler and Kinnear (1932; also cited in Ali and Ripley 1971) mention a record of 1886 in the Anaimalai Hills by W. Davison. Unfortunately, the cited reference (*Ibis*, 1886, p. 146) is wrong, so we could not examine that location for the occurrence of the Yellow-throated Bulbul.

The favoured habitats of the Yellow-throated Bulbul are hill scrub and deciduous forests (Ali 1942). Thus, the Yellow-throated Bulbul should only be expected on the drier eastern slopes of the Anaimalai Hills. In studies of the avifauna of the western and central parts of the Anaimalai Hills, in which tropical rainforest, tea gardens or cardamom and coffee plantations are dominating, the Yellow-throated Bulbul was therefore missed (Kannan 1998, Vijayan 1978, Ali 1969, Stonor 1946).

We looked for the Yellow-throated Bulbul in March, 2001 on the eastern slopes of the Anaimalai Hills. We found two birds some kilometres south of the location where Kannan (1992) observed it, near the open channel, which supplies the Aliyar Dam with water from the western side of the Anaimalai Hills. The birds behaved like a pair: sitting side by side, feeding together, and following each other. Some days later, we located three more specimens on the steep slopes of the hills near the road Pollachi-Valparai. It seemed to us that two of these birds, again possibly paired, were hunting the third one out of their territory.

In the same area, three more species of bulbuls were found: the Red-whiskered Bulbul *Pycnonotus jocosus*, the Red-vented Bulbul *P. cafer*, and the Yellow-browed Bulbul *P. luteolus*. The Yellow-throated Bulbul had the lowest relative abundance of the four congeneric species. At Horsley Hills (Andhra Pradesh), the same bulbuls were recorded as sympatric by Subramanya and Prasad (1996), but there the Yellow-throated Bulbul was the most abundant species.

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16. ASIAN BROWN FLYCATCHER *MUSCICAPA DAUURICA* AT MT. ABU, RAJASTHAN

In the early afternoon of March 25, 2001 we found an Asian brown flycatcher *Muscicapa dauurica* near Sunset Point, Mt. Abu. The bird was busy catching insects attracted to a blossoming mango tree. It was oblivious to our presence and its attention was upon the tree for about ten minutes. It was quite easy to observe the bird as it made sallies to catch the insects in the lower tree canopy.

Being familiar with the species in south India, we were able to identify it easily. It was brownish-grey above and off-white below (including undertail coverts), and had a uniform pale brown-grey wash across the breast and flanks. The whitish eye-ring around the striking large eyes and lore were prominent and distinctive even in the shade of the tree. The throat was conspicuously white. The bill was black, with the basal half of the lower mandible conspicuously pale. The legs and feet were blackish.

According to Ali and Ripley (1996), it is a partial migrant having a disjunct breeding range and its movements are imperfectly understood. As some birds reach their breeding grounds in the Himalaya in

April, the bird we observed was most likely on passage.

As far as we have been able to ascertain, this individual is the first record for Rajasthan. The Asian Brown Flycatcher is not recorded from Rajasthan (Ali and Ripley 1996, Grimmett *et al.* 1998). A record from central Rajasthan (Kazmierczak and van Perlo 2000) can be discounted as there is no basis to believe the species to be a summer visitor. If the species occurs in Rajasthan, it is most likely a rare passage migrant

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17. NEW SIGHT RECORDS OF PIED TIT *PARUS NUCHALIS* IN RAJASTHAN

The pied tit *Parus nuchalis* is endemic in India, confined to Rajasthan and Gujarat (Adam 1873, Ali and Ripley 1987, Hussain *et al.* 1992, Tiwari and Rahmani 1996, Tiwari 2001). According to Tiwari (2001), it is distributed in seven districts of Rajasthan, namely Pali, Jodhpur, Jalor, Sirohi, Ajmer, Jaipur and Nagaur.

While surveying the biodiversity of protected areas (PAs) and other regions of mega-biodiversity in Rajasthan State, I came across this endemic bird thrice in two more districts of Rajasthan (Table 1).

Table 1: Pied Tit sightings in Rajasthan

Date	Number of birds observed	Locality	District
27.vii.2000	2	Sajjangarh Wildlife Sanctuary, on the way to Sajjangarh Fort	Udaipur
1.vii.2001	2	Forest Range Campus, Deola	Udaipur
2.viii.2001	1	Ruliyana village (between Bay and Danta villages)	Sikar

Sajjangarh Sanctuary has dry deciduous forests, with thorny and other shrubs like *Anogeissus pendula*, *Acacia nilotica*, *A. leucophloea*, *A. senegal*, *Dichrostachys cinerea* and *Euphorbia caducifolia* in the foothill zone and middle slopes. *Boswellia serrata* and *Lannea coromandelica* are common tree species in the upper reaches of the Sanctuary.

Deola is a small village situated at the northwestern outskirts of Phulwari Wildlife Sanctuary in Kotra tehsil, Udaipur district. There are dense forest patches in Kotra tehsil, but the environs of Deola village are highly degraded. Thorny species are not very common in this area, except *Anona squamosa* and *Jatropha curcas*.

The pied tit has also been observed by Raza Tehsin (pers. comm.) in Jamunia-ki-Nal, near Udaipur city. This is a moist valley with a semi-perennial stream. The adjacent hills bear thorny forests.

Ruliayana village is very near Harshnath hill, the highest point in Sikar district. This area is surrounded by many protected forest blocks, namely Deogarh, Rewasa-Jheen Mata, Bhoya-Dungri, and Raghunathgarh, which have thorny dry deciduous and scrub forests. *Anogeissus pendula*, *Acacia nilotica*, *A. leucophloea*, *A. senegal*, and *Euphorbia caducifolia* are common here. *Prosopis juliflora* and *Acacia tortilis* are also present at many places, especially near the foothills.

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18. ADDITIONS TO 'THE BIRDS OF GOA' (LAINER 1999)

In 'The Birds of Goa' (Lainer 1999a, b), records up to July 1997 were incorporated. The present note includes all 'new sightings' made since then (up to July 12, 2001) and corrects two inadvertent omissions. All observations, if not attributed otherwise, are by the author. For easy reference and in continuance of the original paper, the number in brackets after the serial number refers to the 'Synopsis number' as used by Ali and Ripley (1995). The common and scientific names follow Manakadan and Pittie (2001). Unconfirmed records of birds that are difficult to identify in the field are appended.

ADDITIONS TO THE SYSTEMATIC LIST

383. (9) **Wedge-tailed Shearwater**
***Puffinus pacificus* (Gmelin)**

During one of my regular seabird watches, I observed a single pale morph specimen skimming low over the waves almost a kilometre off the coast of Anjuna (Bardez) on September 20, 1998. Another pale morph was spotted *c.* 300 m offshore in perfect viewing conditions on July 12, 2001. Both birds were moving purposefully in a southerly direction.

384. (73) **Greater Flamingo**
***Phoenicopterus ruber* Linnaeus**

Frost, Manville and the author observed a single bird in a saline lagoon on Divar (Tiswadi), a large island in the inland-estuary of the Mandovi river, on November 3 and 4, 2000.

385. (155/156) **Common Buzzard**
***Buteo buteo* Linnaeus**

Apparently a scarce, but regular winter visitor. There are dozens of records by reliable British, Dutch and Scandinavian bird watchers, in whose countries the Common Buzzard is a common sight. Pitt (1995) observed the first specimen at Baga (Bardez) in December 1994. I have seen single birds on three occasions in March and October, 1998. The Common Buzzard seems to favour the coastal belt, though there are two records from the midland plateau region and one from the Western Ghats strip.

386. (171) **Lesser Spotted Eagle**
***Aquila pomarina* Brehm**

A near adult specimen of this raptor was seen in November and December 1998 in the Neura wetlands (Tiswadi). Six immature birds were recorded from wetlands of the North Goa coastal belt, in October and November 1999 by Frost and this author. There are numerous sightings of doubtful value by visiting British and Scandinavian birders, nearly all from the coastal belt.

387. (220) **Amur Falcon**
***Falco amurensis* Radde**

Earlier known as the Red-legged Falcon *F. vespertinus amurensis*, the first sighting was of an adult male specimen at the coastal Dona Paula plateau (Tiswadi), in November 1997 (Lynes 1999). Since then, males, females and juveniles have been recorded by various observers and this author at Terakol (Pernem), Baga, Saligao, Fort Aguada (Bardez); Chorao, Carambolim and Corlim (Tiswadi), every year between November 8 and December 3.

388. (313) **Small Buttonquail**
***Turnix sylvatica* (Desfontaines)**

On December 9, 1998, a single bird was observed foraging under bushes on a grassy, lateritic plateau between Arpora, Parra and Verla-Canca (Bardez), hardly 3 km from the coast (Frost pers. comm.).

389. (437) **Great Stone Plover**
***Esacus recurvirostris* (Cuvier)**

Two birds were seen by Frost, Manville and the author in flooded fallow paddy fields on Divar, on October 8, 1998 and a single bird on January 17, 2001 in a prawn farm on Chorao, both riverine islands in the inland-estuary of the Mandovi.

390. (415) **Rufous-necked Stint**
***Calidris ruficollis* (Pallas)**

A single bird was spotted among *c.* 1000 waders, on Divar island (Tiswadi), on September 17, 1999 (Frost and Lainer, under prep.). This first sighting was confirmed when two birds with remnants of the breeding plumage were recorded on August 3, 2000, on the same mudflats and by the same observers. Further sightings of up to two birds on December 13, 2000, 17th January and 2nd February, 2001 at Shiroda (Ponda) and Divar suggest that this very easily overlooked species might be a more or less regular winter visitor.

391. (418) **Long-toed Stint**
***Calidris subminuta* (Middendorff)**

British bird watchers reported that two birds were present in freshly ploughed, irrigated paddy fields next to the inland-estuary of Mandovi river, at Sta. Cruz (Tiswadi) for two weeks in mid-November 2000 (Holt pers. comm.). In the morning of November 24, 2000, I recorded two birds in the same locality, while Frost (pers. comm.) observed 7 specimens in the late afternoon. On December 13, 2000, a loose group of more than 8 birds was sighted in freshly ploughed paddy fields at Shiroda (Ponda). A specimen moulting into breeding plumage was seen in a saltpan in the inland-estuary of the Mandovi, between Panaji and Ribandar (Tiswadi) on April 29, 2000 by Frost and this author.

392. (459) **White-winged Black Tern**
***Chlidonias leucopterus* (Temminck)**

One bird, moulting from adult summer to winter plumage, was sighted on Morjim beach (Pernem), on August 18, 1998. Up to 5 birds in various stages of moult and in first summer plumage frequented mudflats on Divar Island between mid-September and the first week of October. All records were by Frost, Manville and this author.

393. (459a) **Black Tern *Chlidonias niger* (Linn.)**

A juvenile specimen was observed in the company of a White-winged Black Tern, two whiskered terns and a gull-billed tern on mudflats of Divar Island (Tiswadi) on September 13, 1999, and on mudflats in the estuary of the Chapora river (Bardez/Pernem), on October 15, 1999, by Frost and this author. The few previous records in India are either from inland waters or from the East Coast (Grimmett *et al.* 1998).

394. (581) **Lesser Cuckoo**
***Cuculus poliocephalus* Latham**

This cuckoo, previously relegated to the Appendix as unconfirmed, was collected by Saha and Dasgupta (1992) in the Bhagwan Mahavir Wildlife Sanctuary, in September 1977. More recently, Frost, Manville and this author recorded a female or immature bird in the Bondla Wildlife Sanctuary, on October 29, 1999.

395. (759) **Oriental Broad-billed Roller**
***Eurystomus orientalis* (Linnaeus)**

On March 14, 2001, Frost (pers. comm.) with a small party of visiting British bird watchers observed two, possibly three, birds in semi-evergreen foothill forest in the Cotigao Wildlife Sanctuary (Canacona).

396. (940) **Bay-backed Shrike**
***Lanius vittatus* Valenciennes**

An immature bird, moulting into adult plumage, was seen on a wide cultivated forest clearing in the Cotigao Wildlife Sanctuary, in mid-October and mid-November 1998, by Frost and this author. There are 8 sightings by visiting bird watchers at Arambol, Morjim (Pernem); Anjuna-Vagator, Baga (Bardez) and Carambolim (Tiswadi), the earliest dating back to December 1995 (Welland 2000). All of these were in November, December and January.

397. (943) **Rufous-tailed Shrike**
***Lanius isabellinus* Hem. & Ehr.**

Holt (1996) observed a first-winter bird of the subspecies *isabellinus* near Santa Cruz (Tiswadi) in December 1996. Since then a number of sightings of the same race have been reported by Frost (pers. comm.) and visiting birders, from Baga (Bardez), Chorao and Divar (Tiswadi), during early November to early February.

398. (1036) **White-bellied Treepie**
***Dendrocitta leucogastra* Gould**

On April 20, 2001 a single specimen was spotted in very dense, but not tall evergreen forest, right on the eastern border of Goa towards Uttar Kanara (Karnataka), near the village of Kuveshi and above Dudhsagar waterfalls by Frost, Manville and this author.

399. (1748) **Tickell's Thrush**
***Turdus unicolor* (Tickell)**

A male specimen was collected by Saha and Dasgupta (1992) in the Cotigao Wildlife Sanctuary, in February 1978.

400. (2044) **Red-headed Bunting**
***Emberiza bruniceps* Brandt**

A single male was observed in the Neura wetlands (Tiswadi), in mid-December 1998 (Frost and Lainer, under prep.).

ADDITIONS TO THE APPENDIX

8. (32) Lesser Frigatebird
***Fregata ariel* (G.R. Gray)**

One juvenile bird seen *c.* 1.5 km off the Anjuna (Bardez) coast, on September 18, 1998.

9. (412) Red Knot
***Calidris canutus* (Linnaeus)**

A single bird seen among Sanderlings *Calidris alba* and Greater Sand Plover *Charadrius leschenaultii* on Morjim (Pernem) beach, on September 18, 1998.

December 18, 2001

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19. FURTHER CHELONIAN RECORDS FROM MIZORAM IN NORTHEASTERN INDIA

The turtles and tortoises of Mizoram State in northeastern India were virtually unknown till recently (Choudhury 2001, Pawar and Choudhury 2000). In these works, however, the Champhai district in eastern Mizoram was not covered. The district was formerly part of Aizawl district. The entire area is hilly; the highest peak is Lengteng (2,141 m above msl). A field trip was made in February 2001, during which two species were recorded which have been summarised below.

Brown Hill or Asian Brown Tortoise
***Manouria emys* (Schlegel & Müller 1840)**

Two preserved shells were seen and examined at Lamzawl village, 1,000 m above msl. Both were reportedly obtained from the top of Lengteng (around 2,000 m above msl) (23° 50' N, 93° 15' E) and their meat eaten. The measurements are given in Table 1.

Earlier records from Mizoram were from Phura and Sangau in Saiha district (Choudhury 2001), and Dampa and Ngengpui Sanctuaries (Pawar and Choudhury 2000), all in western and southern Mizoram. These were the first records from the entire eastern part, that too from higher elevations (Fig. 1). The plastron pattern of these two specimens resembled the subspecies *phayrei* as did the specimens in Pawar and Choudhury (2000). However, those examined in Choudhury (2001) were similar to *emys-phayrei*

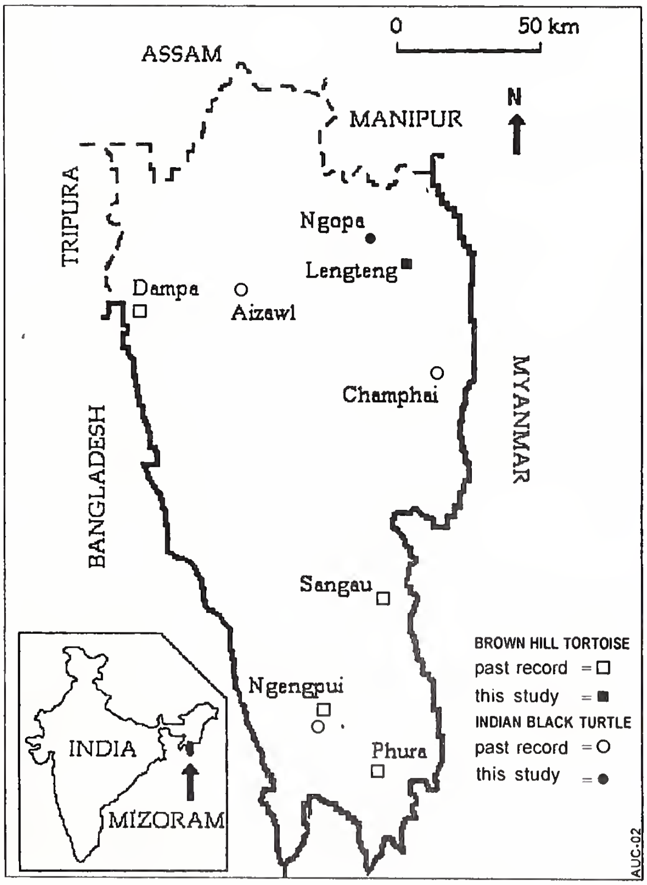

Fig. 1: Map of Mizoram showing the places mentioned in the text

Table 1: Measurements of specimens mentioned in the text (in cm)

Specimen/Site	SCL	CCL	SCW	CCW	PL(gt)	PL(n-n)	PW	Remarks
Manouria emys								
1. Lamzawl (Lengteng)	46.4	52.5	34.5	49.0	46.0	42.0	31.5	
2. Lamzawl (Lengteng)	39.7	46.5	30.0	41.5	39.5	36.0	25.0	
Melanochelys trijuga								
1. Ngopa	25.5	27.0	18.0	24.5	24.0	23.5	15.5	Weight 1.5 kg

SCL=straight carapace length; CCL=curved carapace length; SCW=straight carapace width; CCW=curved carapace width; PL=plastron length; (gt)=greatest; (n-n)=notch to notch; PW=plastron width.

intergrades. This significant variation in a relatively small area was noteworthy.

Indian Black Turtle
Melanochelys trijuga (Schweigger 1812)

A live turtle was examined at Ngopa town, 1,100m above msl. It was reportedly obtained from the nearby Tuivai river (around 450 m above msl; 23° 53' N, 93° 10' E) and kept as a pet. The river also marks the boundary between Aizawl and Champhai districts in that stretch. The measurements are given in Table 1.

Earlier records from Mizoram were from Ngengpui Sanctuary and adjacent areas of south Mizoram (Pawar and Choudhury 2000). The present record was the first from the entire northern and eastern part of the State (Fig. 1).

I would also like to correct a printing error in Choudhury (2001). In Tables 1 and 2, (gt) and (n-n) were only meant for PL and not SCW or CCW as printed (see headers).

I would like to thank N.R. Pradhan, H. Tlangkhuma, Zomawia, Hakim and the Range Officer of Murlen for help during my field study.

July 8, 2002

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20. FIRST RECORD OF THE COPPERHEAD SNAKE *ELAPHE RADIATA* FROM MADHYA PRADESH

The Copperhead Snake *Elaphe radiata* (Schlegel) has hitherto been reported only in Eastern Himalayas, northeast Orissa and Bengal. It has never been reported from Central India. However, during field excursions in Kanha National Park (22° 17' N, 80° 30' E) situated in the Mandla and Balaghat districts of Madhya Pradesh, I spotted this snake twice.

The first time was on July 26, 2001 at *c.* 1130 hrs in the Supkhar locality of the National Park. The dead snake was photographed and measured. It was 2.13 m in length. The specimen which has been preserved in the museum of the Kanha National Park was identified by Mr. Eric D'Cunha as *Elaphe radiata* and confirmed by Mr. J.C. Daniel on November 9, 2001.

Another specimen was spotted during August in Parsatola locality with Mr. B.R. Nagpure, Range Officer, Kisli. These records not only extend the range of *Elaphe radiata* to eastern Madhya Pradesh, but also add a new reptile species to the fauna of Madhya Pradesh.

I thank Mr. Eric D'Cunha and Mr. J.C. Daniel for identifying the snake.

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21. NEW RECORD OF AN ENDEMIC SPECIES, *PUNTIUS OPHICEPHALUS* (CYPRINIFORMES: CYPRINIDAE) FROM TAMIL NADU PART OF WESTERN GHATS

Puntius ophicephalus, a rare barb having very restricted distribution, is known only from the Periyar drainage of Kerala. It is characterized by an elongated *Channa*-like body. Raj (1941) described this species

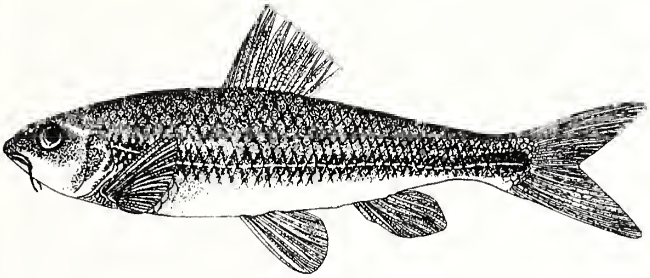

Fig. 1: *Puntius ophicephalus*

Table 1: Morphometric data of *Puntius ophicephalus*

Morphometric characters: Proportions	Range	Mean	Standard Deviation
Standard length / Body depth	3.83-4.52	4.19	0.14
Standard length / Head length	3.93-4.32	4.10	0.20
Head length / Eye diameter	3.55-4.42	4.14	0.25
Head length / Inter-orbit width	2.29-2.70	2.48	0.14
Head length / Snout length	3.04-3.55	3.18	0.15
Head length / Pectoral fin length	1.17-1.40	1.26	0.07
Head length / Pelvic fin length	1.12-1.55	1.35	0.12
Head length / Maxillary Barbels	3.10-3.82	3.48	0.28
Maxillary Barbels / Eye diameter	1.07-1.39	1.19	0.11
Standard length / Pectoral fin length	4.85-5.50	5.17	0.22
Standard length / Pelvic fin length	5.13-6.08	5.57	0.30
Standard length / Predorsal distance	2.06-2.17	2.12	0.14
Pelvic to vent / Distance to Anal fin	6.59-8.76	7.50	0.86
Length of caudal peduncle / Height of Caudal peduncle	1.35-1.70	1.56	0.11

from Kallar stream, a tributary of Pambiyar river (adjoining Periyar lake), Kerala. Later, Silas (1951) recorded it from a tributary of Manimala river (Periyar river basin) at the base of Peermedu hills. For a long time, there was no further record of the species from these areas. Recently, Zacharias *et al.* (1996) rediscovered this species from Malapara at Periyar Tiger Reserve. So far, the distribution of the species had been restricted to the Periyar river basin, Kerala and it has been considered endemic to this basin. During a recent survey on fish habitats in the Western Ghats streams, a fairly good number of *Puntius ophicephalus* was collected from an east flowing stream, Surlitheertham, a tributary of Vaigai river, Tamil Nadu.

Description: D III/7; P I/12-13; V 1/8; A II/5; C 19; L. tr. scales 7½ 3½. Body elongate, dorsal and ventral equally arched; its depth 3.83 to 4.52 times in standard length. Head short and dorsally compressed, head length 3.93 to 4.32 times in standard length. Mouth sub-inferior, lips moderately developed and lower labial fold interrupted. Barbels two pairs, maxillary pair longer than rostral pair, its length 1.07 to 1.39 times in eye diameter. Dorsal fin inserted nearer to tip of snout than the caudal fin base. Ventral fin originates just behind the origin of dorsal fin. Lateral line straight and complete, with 42-44 scales; predorsal scales 15. Further morphometric characters are given in Table 1.

Colour: In life; dorsal black, flanks rich golden colour. Opercle has a mark of dark olivaceous-green on cheek. Eyes green. A dark band runs along the lateral line, which is composed of concentrated fine black spots on the base of lateral line. Belly and abdomen silvery white. Pectoral fins dark green with orange tinge. Dorsal pelvic, anal and caudal fins orange. After preservation: dorsal blackish-brown up to lateral line, dark above and lighter lateral; ventral pale yellowish-white. All fins are dull white.

Habitat and Ecology: The Surlitheertham stream is a tributary of the east flowing Vaigai river. The sampling site is located 7 km from Kambam town in Theni district (8° 51' 39.0" N, 77° 18' 40.2" E). It is an important local picnic spot. Downstream it is highly disturbed by bathing and pilgrimage activities. Specimens were collected around 4 km above the falls at an altitude of 545 m above msl, with a riparian cover of 40%. Not a single specimen could be collected in the downstream area. *P. ophicephalus* prefers larger pools and riffle habitats in forested streams. Adults prefer pools with thick vegetational cover. It hides in the bedrocks and boulder undercut. Juveniles prefer riffle (swift flowing) habitats.

Distribution: Periyar drainage in Kerala. Kallar, a tributary of Pambiyar river south of Pachakani estate (Jayaram 1999); Mundakayam stream, a tributary of Manimala river at the base of Peermedu Hills (Menon 1999) and Malapara stream in Periyar Tiger Reserve (Zacharias *et al.* 1996). This species has been recorded for the first time from the east flowing Surlitheertham stream in Vaigai river (east flowing), in Tamil Nadu.

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22. SEXUAL DIMORPHISM OF THE PIG FACE BREAM *LETHRINUS RUBRIOPERCULATUS* (SATO) FROM SOUTHWEST COAST OF INDIA

Heterosexual animals often exhibit sexual dimorphism in their morphology. However, since it is not uncommon or taxonomically important, only a few observations have been made on sexual dimorphism in freshwater fishes, such as *Puntius filamentosus* (Thobias 1974), *Tetraodon travancoricus* (Inasu 1993) and marine fishes, such as *Narcine timlei* (Waghray 1985), *Priacanthus hamrur* (Tessy and Inasu 1998a), and *Pomadasys maculatus* (Tessy and Inasu 1998b). *Lethrinus rubrioperculatus* (Sato), a carnivore, inhabits the coastal seas and is commercially exploited in the southwest coast. Day (1958) described the genus *Lethrinus* based on 8 species. Fischer and Bianchi (1984) described 18 species of *Lethrinus*, but sexual dimorphism was not described for any of them.

During a study on the biology of perches on the southwest coast, about 43 specimens of the Pig Face Bream *Lethrinus rubrioperculatus* were caught in an area 8° 26' N-76° 51' E to 7° 41' N-77° 11 E (Vizhinjam to Kanyakumari) within a depth range of 39-54 m. Samples were collected by a bottom trawl (mesh size 30 mm at the cod end) by the trawler *Matsya Varshini* during January - March, 2001.

Morphometric parameters such as Total Length, Standard Length, Head Length, Caudal Peduncle Length, Caudal Peduncle Width, Eye Diameter and Inter-orbital width were measured and compared in the two sexes. Sexual dimorphism was exhibited by *Lethrinus rubrioperculatus* (Sato) (Figs 1a, 1b). The females are larger than the males in all the observed morphometric parameters. Moreover, body weight is greater than the males of the same age group (Table 1).

Table 1: Mean morphometric parameters (in cm) of *Lethrinus rubrioperculatus* (Sato)

Morphometric parameters	Male	Female
Total Length	32.40	33.40
Standard Length	25.40	26.00
Total Weight (gm)	489.50	550.50
Head Length	8.25	8.85
Inter-orbital Width	2.50	3.00
Caudal Peduncle Length	3.45	3.95
Height of Caudal Peduncle	2.65	3.10

The upper jaw of males extends forward and is broader than in females (Figs 2a, 2b). The dermosphenoticum in males is conspicuously protruding, whereas it is flattened and not so protruding in females (Figs 2a, 2b). There are two rows of large scales dorsoventrally located above the pectoral fin base in males, while there is a single row of scales in females (Figs 2a, 2b).

The posterior part of the soft rays of the dorsal fin is more filamentous and protrudes above the upper margin in males, while it is not so filamentous and

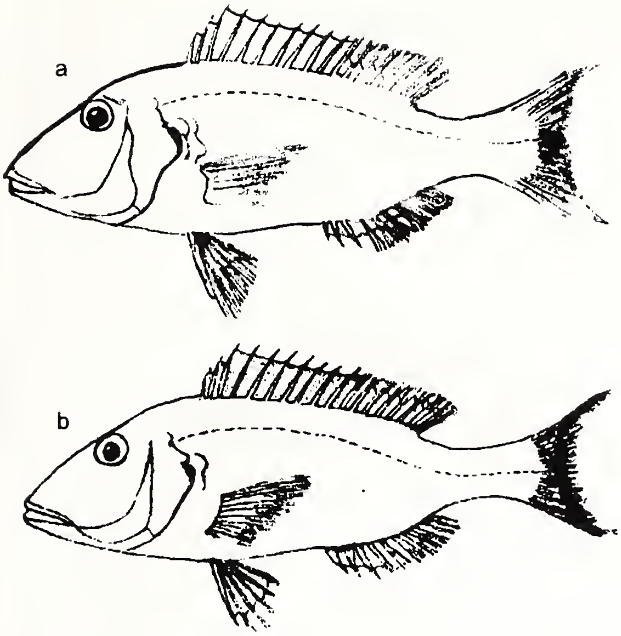

Fig. 1: *Lethrinus rubrioperculatus* (Sato) a: Male; b: Female

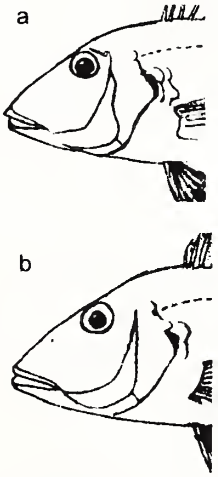

Fig. 2: Morphological difference in the head of *Lethrinus rubrioperculatus*, a: Male; b: Female

protruding in females (Figs 3a, 3b). Soft rays of pectoral fin and anal fin are also more filamentous in males than in females. Interspinous membrane in females occupies a larger area between the two soft rays than in males (Figs 3a, 3b).

Inter-orbital width and eye diameter is greater in females than in males (Table 1). The opercular margin of males has a sharply marked edge, while it is rounded in females. The scales at the point of commencement of lateral line also differ between the sexes (Fig. 2). The distance between lateral line and caudal peduncle profile, and the caudal peduncle width and length are greater in females than in males (Table 1).

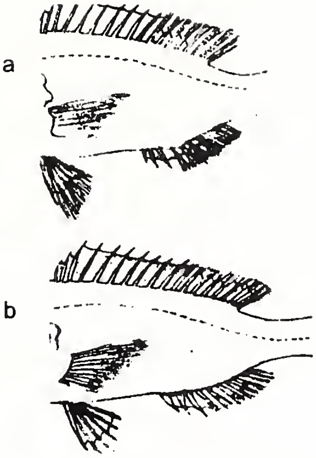

Fig. 3: Dorsal and anal fin soft rays of *Lethrinus rubrioperculatus*, a: Male; b: Female

Contrary to our observations, the soft rays of dorsal and anal fin were recorded to be more filamentous in females in *Priacanthus hamrur* (Tessy and Inasu 1998a) and *Pomadasys maculatus* (Tessy and Inasu 1998b).

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23. RECORD OF *STRUMIGENYS EMMAE* (EMERY) (FORMICIDAE: MYRMICINAE) FROM BANGALORE, KARNATAKA AND A KEY TO INDIAN SPECIES

Strumigenys – the largest Dacetine genus – comprises *c.* 169 species that are distributed in all the zoogeographical regions except the Palearctic (Bolton 1995). Only two species of *Strumigenys* have so far been reported from India (Bolton 1995; Bingham 1903), namely *S. godeffroyi* Mayr and *S. smythiesii* Forel which were originally described in the genus *Epitritus* Emery, and later placed in genus *Quadristruma* by Brown (1949). *Quadristruma* is a small genus containing only two species, *Q. eurycera* (Emery) and *Q. emmae* (Emery). Bolton (1983) considered that the genus *Quadristruma* Brown differs from *Strumigenys* only in the number of antennal segments and suggested that *Quadristruma* Brown would eventually fall into synonymy with *Strumigenys* Smith. *Q. eurycera* is known only from New Guinea. *Q. emmae* has been recorded widely from tropical and temperate regions of the world, and is thought to be of Afrotropical origin (Bolton 1983).

Bolton (1999) ultimately synonymized *Quadristruma* with *Strumigenys* and included *Q. emmae* and *Q. eurycera* in *Strumigenys*. There is a single record of *Q. emmae* from India, but no locality is mentioned (Bolton 1983). I now report *Strumigenys emmae* from Bangalore, India.

Strumigenys emmae (Emery)
(Fig. 1a-b)

Diagnostic features: Total length 1.86 mm (Fig. 1a), HL: 0.48 mm, HW: 0.39, CI: 81.25, ML: 0.15, MI: 31.25, SL: 0.21, SI: 52.5, AL: 0.48 and PW: 0.22.

Mandibles linear, strongly curved and each with a strong fork of two long spiniform teeth in a vertical series. Anterior clypeal margin broad, projecting well beyond the mandibular bases on each side with numerous, small, spatulate to spoon-shaped hairs (Fig. 1b). Antennae 4-segmented, the scape narrow basally, but broadening to mid-length, then narrowing again to the apex. Eyes very small, situated just above the ventral scrobe margin. Pronotum more or less flat dorsally, anteriorly rounding into the sides. Metanotal grooves absent. Dorsal alitrunk and upper half of the propodeal declivity reticulate-punctate. Pronotal humeri each with a straight clavate hair. In profile, pedicel segments with spongiform appendages. Base of first gastral tergite with a continuous row of basal costulae. Petiole, post petiole and gaster with short, narrowly clavate hairs. Colour yellowish-brown.

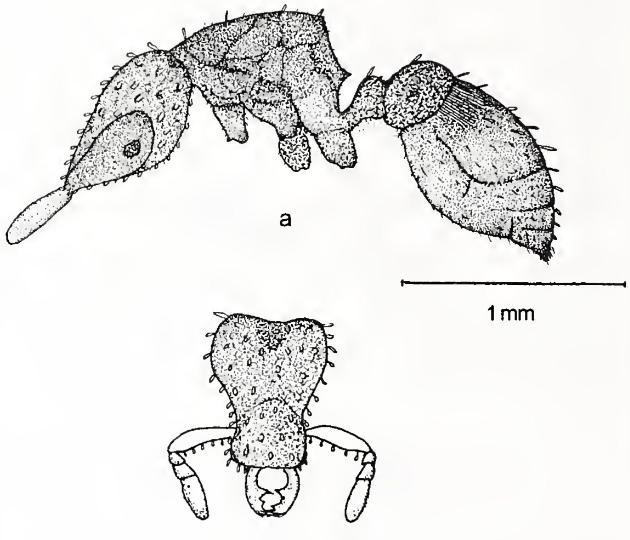

Fig. 1: *Strumigenys emmae* worker, a. Body in profile, b. Head in front view

Material Examined: 1 worker, INDIA, Karnataka, Bangalore, Indian Institute of Science Campus, Coll: Deepalakshmi & Charusheela, 1997.

Distribution: Hawaii, Guam, Florida, Puerto Rico, West Indies, Cuba, Surinam, Sumatra, Singapore and New Guinea (Brown 1949), Philippines, New Hebrides and Australia (Wilson and Taylor 1967) Bahamas (Kempf 1972), West Africa and Ghana (Bolton 1973), India, Malaysia, Sulawesi and Equatorial Guinea (Bolton 1983).

Remarks: *S. emmae* (Emery) is distinguished from other Myrmicinae by its 4 segmented antennae.

KEY TO INDIAN SPECIES OF *STRUMIGENYS* SMITH
(Modified from Bingham 1903)

1. Antennae with 4 segments, mandible with 2 teeth, length less than 2 mm .... *emmae* (Emery)

— Antennae with 6 segments, mandible with 3 teeth, length more than 2 mm 2

2. Pronotum punctured, opaque, mandible with 3 teeth of which the apical is smallest .... *godeffroyi* Mayr

— Pronotum not punctured, smooth and shining, mandible with 3 teeth .... *smythiesii* Forel

ACKNOWLEDGEMENTS

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24. ON THE OCCURRENCE OF *MARUMBA CRISTATA* (BUTLER 1875), LEPIDOPTERA: SPHINGIDAE, IN SHIMLA, HIMACHAL PRADESH

In an earlier paper on the Hawkmoths (Sphingidae) of the Kumaon Himalaya (Smetacek 1994), *Marumba cristata* (Butler) was noted as a new record for the area. Prior to that study, D'Abrera (1986), Bell and Scott (1937) and Hampson (1892) had recorded this moth from Sikkim eastwards, with a global distribution extending to "China, Taiwan, Peninsular Malaya, Sumatra, Borneo, ?Java and ?Palawan" (D'Abrera 1986). Along this range the latter author recognized four subspecies.

Bell and Scott (1937) bred a large number of Hawkmoths in India. One of the sites where this work was carried out was Mussoorie and the Dun valley in the Garhwal Himalaya prior to 1937. They did not obtain *M. cristata* in that area, nor did the earlier collectors, such as Rev. J.H. Hocking, Mr. Graham-Young, Majors Yerbury and Harford in Garhwal and present day Himachal Pradesh. In the Himalaya west of Nepal, Mussoorie, Shimla, Kulu and Dharamsala were by far the best worked localities for moths, with fewer records from other localities such as Almora, Nainital, Dalhousie and Murree. Major Harford, in particular, collected Hawkmoths in Shimla but did not record *M. cristata* there, although he obtained rarities such as *Thaumoecha uniformis* Butler and *Langia zenzeroides* Moore.

In a paper on the Hawkmoths of Kumaon (Smetacek 1994), I suggested that this moth might have extended its range to Kumaon in the period subsequent to Bell and Scott's (1937) study. However, since Kumaon is east of the localities surveyed in the previous studies mentioned above, there was a possibility that *M. cristata* had been established in Kumaon for centuries, as a detailed study of the moth fauna of this area had not been undertaken earlier. The confirmation of the possibility of *cristata*'s recent range extension, obviously, would lie in its appearance in localities surveyed in the second half of the 19th and first half of the 20th centuries.

On July 17, 1993, I found the right forewing of a specimen of *Marumba cristata* (4.1 cm long) on a hotel balcony on the western outskirts of Shimla town. The moth had evidently been attracted by the outdoor lights, which had been left on all night, and had fallen prey to a bird or gecko there. The wing bears over ten beak or tooth marks along the costa and at the base, none of which punctured the wing. The wing is whole and in good condition except the discal area where some scales have been rubbed off. Most of the markings beyond the discal line are clearly distinguishable, enabling it to be definitely placed as a wing of *M. cristata*.

I was unable to visit Shimla subsequently at a suitable season. This single record is of importance, even if the specimen was merely a straggler, since previous workers had not recorded it there. Therefore, it appears to have moved into the area recently, i.e. since Bell and Scott (1937) completed their studies in Mussoorie.

Moving from east to west, Mussoorie is roughly 100 km west of Bhimtal in Kumaon. Bhimtal is the westernmost site recorded for *cristata* (Smetacek 1994). This species has not been recorded from Mussoorie, but its appearance in Shimla (roughly 100 km northwest of Mussoorie and 200 km west of Bhimtal) suggests the existence of *cristata* in the area between Bhimtal and Shimla, probably around Mussoorie.

In Kumaon, *cristata* has been recorded in all the three ranges of the Himalaya. In the outermost range, where populations have been monitored for over two decades, it is a common, well-established species, which can become very common if there are no forest fires and rainfall is heavy for several consecutive years.

The present record confirms that at least some Hawkmoths have extended their range westwards along the Himalaya during the second half of the twentieth century.

February 7, 2002

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25. *PLEURONA FALCATA* WALKER, AN ADDITION TO THE NOCTUID FAUNA OF THE INDIAN MAINLAND

In the Indian sub-region, the species *Pleurona falcata* Walker (Lepidoptera: Noctuidae) has been reported from Burma (Myanmar) and the Andaman Islands (Hampson 1894), but not from the Indian mainland. A single specimen was recorded by this author in the Kumaon Himalaya. This record extends the known distribution of this moth considerably westwards and northwards. It was previously known from tropical areas, but the present record is from *c*. 29° 20' 43" N.

The following is a description of the specimen:

***Pleurona* Walker**
1866. Cat. Lep. Het. Brit. Mus. Lond. 35: 564.
***Pleurona falcata* Walker**
1866. Cat. Lep. Het. Brit. Mus. Lond. 35: 564.

Material Examined: 1 ex. (female): 20.xi.1998, Jones Estate, Bhimtal, Kumaon 1,500 m at MV light. Leg. & coll. Peter Smetacek.

Forewing Length: 17 mm.

Expanse: 38 mm (Hampson 1894 & mihi).

Distribution: Burma, Andamans (Hampson 1894).

Remarks: This taxon should not be confused with *Chilkasa falcata* Swinhoe, which Hampson (1894) included under *Pleurona*, proposing the new name *Pleurona perhamata*, since *Pleurona falcata* was preoccupied by the species being discussed here. The genus *Chilkasa* Swinhoe was subsequently resurrected in recent works such as Barlow (1982); hence *Chilkasa falcata* is a valid name but does not refer to the species being discussed here.

The specimen is in perfect condition. It matches the description and Fig. 310 in Hampson (1894) except in the following points:

1. The ground colour on the *recto* surface is dark purplish-brown, not bright red-brown.
2. On the hindwing *recto*, the series of submarginal specks mentioned by Hampson are part of a crenulate line.
3. On the hindwing *verso*, the medial and postmedial lines are clear and sharply defined, not indistinct.
4. On the hindwing *verso*, the submarginal line is crenulate from the inner margin for two thirds of its length and the remaining third is straight to the costa.

The breeding status of this moth in the Bhimtal valley is uncertain, since this is the only specimen recorded in over two decades of monitoring moth populations at this site. However, it is certainly from a breeding population within Indian borders, since it is inconceivable that the present specimen could have passed its early stages in Myanmar and then traveled to Bhimtal. It is more likely that breeding populations of this moth will be found at low elevation along the Himalaya, at least as far west as Kumaon, particularly in the Terai and Bhabar zones, since this moth is primarily a tropical species.

It seems that the present specimen was a straggler from low elevation attempting to disperse the species. Its appearance in late November further indicates that it is a low elevation species, since there are very few locally established moths on the wing at that time at 1,500 m elevation.

In recent years, a number of typically Indo-Malayan Lepidoptera have been added to the known fauna of the Kumaon Himalaya (Smetacek 1994, 1995, 1998). While the paucity of comparative material from the 19th and first half of the 20th centuries from this area makes it uncertain whether the new records are recent arrivals or have been established here since the records began, in some cases it has been possible to suggest that some hawkmoths and at least one butterfly (Smetacek 1994, 1995) are recent arrivals. In the case of *Pleurona falcata*, I would venture to suggest that it is a relatively recent arrival, probably sometime during the 20th century, since extensive work by a number of workers in the eastern Himalaya and the hills of northeast India during the 19th and 20th centuries failed to discover this moth.

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26. *CORYMICA* WALKER, LEPIDOPTERA: GEOMETRIDAE, IN THE KUMAON HIMALAYA, WITH THE DESCRIPTION OF A NEW FORM OF *C. DEDUCATA CAUSTOLOMARIA* MOORE

Corymica Walker is a small genus of Geometrid moths that occurs from the Indian subcontinent northward to Korea and Japan, and eastward to Sulawesi and Papua New Guinea. These moths are predominantly yellow, with relatively long palps and a distinctively shaped forewing, whose chief features are an acute apex and a dorsal margin with the distal half highly excised. Only males bear a large hyaline fovea near the base of the forewing.

Hampson (1895) and Prout (1915) assigned three species to the genus, while Wehrli (1940) took *vesicularia* Walker out of the synonymy in which these two authors placed it, and treated it as a valid species, raising the number of species to four. Wehrli (1940) also suggested that the taxa treated as subspecies of *specularia* Moore would probably prove to be a good species, which would increase the total number of species in the genus.

Hitherto, no moths of this genus had been reported from the Kumaon Himalaya, although *vitrigera* Butler was described from Dharamsala in Himachal Pradesh. This taxon was treated as a subspecies of *C. specularia* by Prout (1915) and as a synonym of the same by Hampson (1895), whose typical form is known from Bengal and the eastern Himalaya. So *vitrigera* or *specularia* was to be expected in the Kumaon Himalaya, which lies between the two type localities.

However, in view of the observation by Wehrli (1940) on the subspecies of *specularia*, it is possible that *vitrigera* is, in fact, a good species, in which case both *specularia* and *vitrigera* may occur in Kumaon, the latter probably in the main Himalayan range, since the type locality, Dharamsala, is in the main range.

Location

The present study was carried out in the Kumaon Himalaya in the state of Uttaranchal. All records are from the Jones Estate in the Bhimtal Valley, 24 km from the district headquarters of Nainital. The elevation is *c.* 1,500 m above msl. The site lies in the outermost range of the Himalaya and constitutes the micro-watershed between the Bhimtal and Sattal lake systems.

The area is well forested, with the Himalayan oak (*Quercus leucotrichophora* A. Camus) and chir pine (*Pinus roxburghii* Sarg.) as nodal species, interspersed with elements of low elevation deciduous species, such as *Sapium insigne* Trim. and *Erythrina* L. spp. Other species include *Mallotus philippinenis* Muell. Arg., *Bauhinia* L. spp., *Phyllanthus* L. sp., *Pistacia* L. and *Ricinus* L. In addition, a large number of exotic trees and shrubs, such as tea *Nerium* L., and mango *Mangifera* L. make the area botanically diverse.

Climate

The climate is subtropical, with a maximum summer temperature of *c.* 36 °C in late May and June and a minimum of 0 °C in January, although in some years the temperature does not fall below 6 °C. Rainfall is heavy, especially during the southwest monsoon from June to September. Relative humidity during this period is around 40%, while in March and April, it is generally less than 15%. Relative humidity mentioned in this paper was measured indoors unless otherwise mentioned, since it tends to vary greatly outdoors over short periods of time.

Flying Time

Members of the Genus *Corymica* have been recorded in different years between March 1 and April 6 and again from June 2 continuously to November 14. During the warmer period of the year, these moths are not on the wing during most of April and May, when relative humidity varies between 1% and 20%, except on overcast days when it rises to 30% outdoors for a short while. It appears that these moths are not on the wing when humidity is less than 10%.

Attractants

Moth populations have been monitored at the main study site in Jones Estate near Bhimtal for three decades. To study *Corymica*, the main attractant used was artificial light, a petromax during the early 1970s, and ordinary tungsten filament lamps of 60 W and 100 W, but most often mercury vapour lamps of 125 W or 160 W. These moths have not been recorded at flowers or other sources of sugar.

Resting attitude

All members of this genus rest with the wings outspread. The forewings are contorted along their length, so that the costa is held furthest off the substrate and the remainder of the forewings slopes down to the hindwings, which are held level and close to the substrate. In this position, they seem to resemble a dried yellow leaf, curled along the edge, although the imitation is only a rough one and is not convincing if the moth is viewed away from a suitable backdrop.

These moths are proficient walkers and, upon settling, often walk a few centimetres with the wings outspread until they are satisfied and then settle down. It seems possible that they move about in order to settle in a certain position relative to the light source.

Flight

The flight is weak and fluttering. These moths are incapable of gliding flight. They settle frequently. After settling, if they are disturbed, they fly off but settle again a short distance away after a brief flight, usually lasting less than half a minute.

Systematics

Four specimens of *Corymica specularia* collected during the 1970s were taken by the Late Fred Smetacek Sr. The remaining specimens were taken by the author. All specimens are in the author's collection.

***Corymica* Walker**
1860. Cat. Lep. Het. Brit. Mus. 20: 230.
***Corymica arnearia* Walker**
1860. Cat. Lep. Het. Brit. Mus. 20: 231.

Material examined: 2 exs. : 16.vii.1998 (female); 4.viii.2000 (male).

Forewing Length: 13 mm (mihi).

Expanse: 28 mm (male) (Hampson 1895); 30 mm (mihi).

Distribution: Khasis (Meghalaya); Thyetmyo; Upper Tenasserim (Myanmar); Borneo (Hampson 1895); N. India to Borneo, W. China, Korea, Nagasaki (Japan) (Prout 1915); also eastern marches of Tibet; S. China; Taiwan and Hainan. Flight period June (Wehrli 1940).

Remarks: The type specimen is from Sarawak and there appears to be no reported variation over this moth's vast range.

The present record extends the known distribution of the species westwards to Kumaon. On the whole, it appears to be a low elevation species, with records from Nagasaki in Japan and Guangdong in China.

It is noteworthy that only females have been recorded at Jones Estate. These two specimens are almost certainly individuals that journeyed quite far from their normal breeding grounds in the course of dispersing the species. The main population will probably be found in the Bhabar belt along the foot of the Himalaya and Jones Estate, at 1,500 m, is probably as high as the species ventures.

The specimens examined match Hampson's (1895) description, except in the matter of the medial spot on the forewing costa noted by him, which is lacking in the specimen examined, as well as in the illustration in Hampson (Fig. 101). There is a dark speck at the end of the cell on each wing in the specimens examined, which is not mentioned by Hampson (1895), although these specks appear in the illustration (Fig. 101) in the same work. The medial spot on the inner margin of the forewing is elongate in the specimens examined and encloses a very small white speck, much smaller than in the illustrations in Hampson (1895) and Seitz (1915).

***Corymica deducata* Walker**
1866. Cat. Lep. Het. Brit. Mus. 35: 1569.

Material examined: 3 exs.: *caustolomaria* Moore: 26.vii.2000, 30.vii.2000 (females). *wirthi* nov.: Holotype 20.x.1998 (male); paratype 19.x.2003 female. Leg. et coll. Peter Smetacek.

Forewing Length: 13 mm.

Expanse: 26 mm (Hampson 1895): 28 mm (mihi)

Distribution: Sikkim, Khasis (Meghalaya); Travancore (Kerala) (Hampson 1895); N. India to Korea, Japan and Formosa (Taiwan) (Prout 1915); also Sulawesi (Wehrli 1940).

Remarks: A new record for Kumaon. The type of *deducata* is from Sulawesi. Wehrli (1940), quoting an uncited work of Prout, suggested that *caustolomaria* is the Indian race of the species. He also noted that specimens from Hainan examined by him belonged to *caustolomaria*.

The species occurs in two forms in Kumaon. The typical form with a yellow ground colour and rufous markings is recorded in July (summer brood), while *wirthi* forma nov. is superficially very different, with the ground colour brown with fuscous markings and not a trace of yellow or rufous on both surfaces of the wings. On the *verso* surface, the costa of both wings is broadly paler, as is the inner margin of the forewing. The markings are identical to typical *caustolomaria* on both surfaces. It is the autumn form and appears not to have been recorded from anywhere in this insect's vast range. A similar difference in seasonal forms is evident in the European taxon *Eilicrinia cordiaria* Hübner, which is closely related to *Corymica*.

Wehrli (1940) noted that *caustolomaria* is on the wing in June and July in Hainan, and July in Korea. From this, it would appear to be univoltine in the northern part of its range, which rules out the very existence of an autumn form. However, it is possible that *wirthi* exists in Kerala, although there is no record of it so far. Wehrli (1940) noted that it is a rather rare species, so the lack of records is not unusual and *wirthi* might yet be discovered in Kerala. On the other hand, if it requires a degree of cold not found in Kerala, it might turn out to be restricted to the Himalaya.

The new form is named after Basil Wirth of Reading, U.K., who has worked on Indian Lepidoptera for nearly half a century.

***Corymica specularia* Moore**
1867, Proc. zool. Soc. Lond.: 649, pl. 33, fig. 11.

Material examined: 20 exs.: 1.iii.1974 (female); 10.iii.1977 (female); 6.iv.1999 (female); 13.iv.1981 (male); 20.iv.1992; 1.viii.1973 (female); 1.viii.1992 (female); 7.viii.1997 (female); 10.viii.1995 (male+female)x2; 12.viii.1977 (female); 16.viii.1995 (female); 27.viii.1983 (female); 29.viii.1983 (female); 30.viii.1981 (female); 8.ix.1983 (female); 15.ix.1992 (female); 18.ix.1998 (male); 10.x.1998 (female); 14.xi.1998 (female).

Forewing Length: 16-20 mm.

Expanse: Males 30-34 mm, females 38 mm (vide Hampson 1895); males 34 mm, females to 42 mm (mihi).

Distribution: Japan; Dharamsala (Himachal Pradesh); Sikkim; Nilgiris (Tamil Nadu); Sri Lanka (Hampson 1895). Widespread in India, Japan (Prout 1915). Various localities in China, India, Japan (Wehrli 1940).

Remarks: This is the commonest member of the genus at the study site. In addition to the above specimens, this species has been recorded in June and July. It is on the wing in November only during warm years, such as 1998 and 1999. In 2000, which was a rather cool year due to the prolonged southwest monsoon, the moth was not recorded after October 18, while in 1998 it was recorded nearly a full month later on November 14. The above statement takes into consideration the possibility that the species was on the wing in November 2000, but was not attracted to the MV light at the study site, since not only *specularia* but no moths were attracted during most of the winter of 2000-2001, unlike 1998-1999 and 1999-2000. So far, no seasonal variation has been noted in this species.

The taxon *vitrigera* Butler, which was treated as a subspecies of *specularia* by Prout (1915) and Wehrli (1940) and as synonym of *specularia* by Hampson (1895) was described from specimens from Dharamsala in Himachal Pradesh, northwest of Jones Estate. Dharamsala is in the main Himalayan range, while Jones Estate is in the outermost range. Therefore, the genus probably occurs throughout the Himalayan range as far west as Dharamsala. However, I have not recorded it from any other location in Kumaon or Garhwal so far.

None of the specimens examined in the present study are *vitrigera*. The type of *specularia* is from "Bengal", so *specularia* occurs at least as far west as the Bhimtal valley where Jones Estate is situated. Unless it turns out that *vitrigera* is distributed along the main range and *specularia* along the foothills, *vitrigera* appears to have a rather restricted range.

Discussion

The present study extends the known distribution of *Corymica arnearia*, *C. deducata caustolomaria* and *C. specularia specularia* westwards to the Kumaon Himalaya. The two former taxa are rather rare at 1,500 m, although they are perhaps commoner at lower elevations. It is worthy of note that only females of *arnearia* have been recorded from Jones Estate so far. These individuals probably wandered so high in the process of dispersing the species. In the case of *specularia*, it appears to be well established at this elevation and will probably be found to occur even higher.

The specimens examined in this study have been collected over a period of nearly thirty years. It will be noted that there are no records of *arnearia* and *deducata caustolomaria* prior to 1998. This should not be interpreted to imply that these two taxa were absent from the area prior to 1998, but that they were probably overlooked earlier, although I am more or less certain that they were not attracted to the artificial light at the main study site between 1993 and 1997, when I paid more attention to members of this family. It can safely be stated that both these species appear sporadically at 1,500 m, although they might be well established in a locality not very far from the main study site.

Hitherto, seasonal variation had not been noted in this genus. The form *wirthi* nov. of *C. deducata caustolomaria* differs from the typical form in much the same way as the spring form of the European moth *Eilicrinia cordiaria* Hübner gen. vern. *roeslerstammaria* Staudinger differs from the typical summer form. As in the case of *Corymica*, not all species belonging to *Eilicrinia* Hübner are seasonally dimorphic. The two genera are usually placed close together. I have treated *wirthi* nov. as a seasonal form of *caustolomaria* rather than as an aberration, despite the paucity of specimens and other supportive data. Given the similar trend in *Eilicrinia* and the rarity of this species over its entire range, it seems best to proceed in this manner.

It is possible that *vitrigera* will be found in the main Himalayan range in Kumaon eventually and that *C. specularia specularia* occurs further west along the outer ranges of the Himalaya.

February 11, 2002

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27. ADDITIONAL RECORDS OF BUTTERFLIES FROM MAHARASHTRA

I would like to add the following butterflies to the list of those already known to occur in Maharashtra, within the erstwhile Bombay Presidency Area.

Euploea klugi kollari: The species occurred regularly in the Colaba area of Mumbai from where I took 3 males and 2 females. Further, I took 2 males from Nalasopara and Tulsi Lake, north of Mumbai. At the time I did not consider *klugi* to be a great rarity, as we seemed to see them quite often. In those days, I never took many examples of the same species, being something of a conservationist, even before conservation became an issue. For this reason, I have only two females, as it is so similar to *E. core*. Being somewhat inexperienced then, I was unable to distinguish between *core* and *klugi* females in the field. I am certain that there was a small breeding colony in Colaba, as there were plenty of milkweed (*Calotropis*) plants close by. We were able to observe *Danais chrysippus*, *D. genuta* and *Euploea core core* in all their stages of development. My good friend of many years, Fr. A.E. Bean has also recorded a single male from Lonavala, Maharashtra.

All the *klugi kollari* were taken between May and October 1957 to 1961. As I have not been back to the area since then, I do not know if a breeding population still exists at Colaba. However, the occurrence of *klugi* at Nalasopara and especially Tulsi Lake, an area that I believe may now be protected should provide us with some hope. [Nalasopara is now built up, but Tulsi Lake is within the protected Sanjay Gandhi National Park — Eds]

Neopithecops zalmora dharma: I took a single male of this species in Mahabaleshwar on 21.x.1961. At that time, I was unaware that this species had never been taken in the area before. Both Wynter-Blyth (1957) and Evans (1932) report it from Sri Lanka, South India to Bengal and Kumaon to Burma (now Myanmar). It was only when I read Eliot and Kawazoes' book, BLUE BUTTERFLIES OF THE LYCAENOPSIS GROUP that I realised I might have something very special. Col. John Eliot was good enough to confirm the identity of the specimen in question a couple of years ago.

Fr. Bean, who has taken *zalmora* in other areas, has usually found it flying with *Megisba malaya*. The specimen I took in Mahabaleshwar was flying with *malaya thwaitsei*.

I would suggest that the species does occur in Maharashtra even if it is extremely rare. As it is a very weak flier and found so far inland, I would certainly not consider it to be a 'wind blow'.

Appias wardi: I mentioned this species in an article in the *JBNHS* some 40 odd years ago. I took a single male at Colaba on 5.vii.1957, but feel that this specimen may well have been wind blown from much further south.

May 1, 2001

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28. STUDIES ON THE ODONATA (INSECTA) FROM A BACKWATER SWAMP OF NORTHERN KERALA

Our present knowledge on the odonate fauna of estuarine and brackish water environments in India is confined to the state of Orissa and West Bengal on the east coast (Fraser and Drover 1921, Prasad and Ghosh 1982, 1988). Studies on odonates from the brackish water areas of the west coast of India have not been attempted earlier. Hence, this study was taken up at Chemballikundu, a backwater swamp in north Kerala from August 1999 to September 2000.

Chemballikundu swamp is a floodplain parallel to the Ezhimala hills, formed by rivers Ramapuram, Peruvamba and Kavaayi in Kannur district, situated at 12° 31' N and 75° 14' E. The area receives a mean annual rainfall of 3,000 mm, mainly from the southwest monsoon, from June to September. Maximum and minimum temperatures of 33.4 °C and 18.7 °C are experienced in April and December respectively.

Due to the variation in salinity over the seasons, the vegetation of the area is diverse, comprising of species such as *Nymphaea nouchali*, *Nymphoides indicus*, *Limnophylla heterophylla* and *Hydrilla verticillata*, mixed with tall reeds like *Mariscus javanicus*, *Fimbristylis ovata*, *F. ferruginea* and *F. aestivalis*. The embankments along the marshes and mudflats are covered with patches of mangrove species like *Avicennia officinalis*, *A. marina*, *Excoecaria agallocha*, *Aegiceras corniculatum*, *Achrosticum aureum* and *Acanthus ilicifolius*. The varying microhabitats provide good foraging and breeding grounds for many insects. The water is saline, except for a brief period during monsoon. Collections were made during October 1999 (post-monsoon), February-April 2000 (pre-monsoon) and July-September 2000 (monsoon), to record seasonal variation and other related data. The odonates collected or observed are categorised as follows:

A = Abundant: More than 15 observed during each visit/season
C = Common: More than 8 observed during each visit/season
UC = Uncommon: Not more than 4 observed during each visit/season
R = Rare: Less than 4 observed during each visit/season
NF = Not Found: Not observed during the season.

A total of 21 species of odonates under 19 genera belonging to 3 families were recorded from the wetlands of Chemballikundu. The suborders Zygoptera (damselflies) and Anisoptera (dragonflies) were represented by 8 and 13 species respectively. All the species are new reports from the area, and also from the estuarine ecosystem of western India, whereas *Aciagrion occidentale* and *Mortonagrion varralli* are new additions to the estuarine Odonata of India.

The seasonal collection showed a diversity of 20 species in post monsoon, 12 species in monsoon and 9 species in pre-monsoon. The low species diversity in summer may be due to high salinity resulting from the lowering of water level for aquacultural practices. In summer, the aquatic vegetation and reed beds dry up and the entire ecosystem changes till the onset of the Southwest monsoon. Species such as *Pseudagrion microcephalum*, *Mortonagrion varralli*, *Orthetrum sabina sabina*, *Brachythemis contaminata*, *Diplacodes trivialis*, *Pantala flavescens* and *Tholymis tillarga* were recorded throughout the survey, indicating multivoltinity. The species were identified from the FAUNA

OF BRITISH INDIA SERIES (Fraser 1933-36). The nomenclature follows Fraser (1957), and Prasad and Varshney (1995). A detailed systematic account with data on collection, status and habitat of the species recorded and notes on behaviour, and ecology of some species is given below.

Breeding activities: Intense breeding activity was observed mostly during monsoon and post-monsoon. During July 2000, *Diplacodes trivialis* was observed in wheel position and *Tholymis tillarga* ovipositing on the open water surface. September was favourable for damselflies for mating and oviposition. Many pairs of *Pseudagrion microcephalum* and *Ceriagrion cerinorubellum* were seen in tandem, ovipositing on *Nymphaea nouchali* leaves, intermittently resting on the tall *Fimbristylis* grasses. Pairs of *Rhyothemis variegata variegata* were observed in tandem, hovering over the vegetation during September.

Emergence: Swarms of newly emerged *Diplacodes trivialis* were observed among the sedges bordering the bunds in monsoon (July, 2000). Interestingly, they were not seen during the September survey. Exuviae and emerging swarms of *Trithemis pallidinervis* were seen in September among the mangrove thickets.

Roosting: A small roosting population of *Tholymis tillarga* was observed on *Aegiceras corniculatum*, a small mangrove shrub near the marshland, at around 1900 hrs in July 2000. Mass roosting of *Pantala flavescens* was seen on the tall *Fimbristylis* grasses and *Hygrophila* plants lining the creeks towards dusk (1910 hrs), in July. *Mortonagrion varralli* were seen roosting among the shoreline grasses.

Accompanying behaviour: A small group of 8 individuals of *Brachythemis contaminata* was observed accompanying one of the authors (MJP) during the collection trip. The swarm moved parallel to him, at a height of about 60 cm. When the author stopped to net them, they dispersed; some hovered, some perched on grass. When he resumed wading through the swamp, they followed him. This continued over a distance of *c*. 200 m. Swarms of *Trithemis pallidinervis* also exhibited similar behaviour along the trek path lining the wetlands in September.

Predators: The Chemballikundu wetlands are known for diversity of birds (Jafer 2000). A flock of Blue-tailed Bee-eater (*Merops philippinus*), and Black Drongo (*Dicrurus macrocercus*) were seen capturing larger species of odonates like *Pantala flavescens* and *Tramea limbata similata*, especially in July and September, when the prey species were abundant.

SYSTEMATIC ACCOUNT

Suborder: Zygoptera
Superfamily: Coenagrionoidea
Family: Coenagrionidae
Subfamily: Pseudagrioninae

1. ***Ceriagrion cerinorubellum* (Brauer 1865)**

Material examined: 1M, 1F; 1.x.1999. 2M, 2F; 14.ix.2000.

Field notes: Abundant among sedges along with *Pseudagrion microcephalum* immediately after the monsoon. Many pairs observed in tandem, ovipositing on the floating leaves of *Nymphaea nouchali*, during September, 2000.

Status: Pre-monsoon: NF, Monsoon: C, Post-monsoon: A.

2. ***Ceriagrion coromandelianum* (Fabricius 1798)**

Material examined: 1M; 1.x.1999.

Field notes: Common during the monsoon, frequents reed beds and aquatic grasses.

Status: Pre-monsoon: NF, Monsoon: R, Post-monsoon: C.

3. ***Pseudagrion microcephalum* (Rambur 1842)**

Material examined: 1M, 1F; 1.x.1999. 1F; 2.i.2000. 2F; 21.vii.2000. 2M, 3F; 14.xi.2000.

Field notes: Most common. Males regularly collected throughout the survey from the bund lines, observed slowly sailing through the tall reeds. Abundant immediately after monsoon. Pairs found in tandem and wheel position, also seen ovipositing on *Limnophylla heterophylla* and *Nymphaea nouchali* leaves, in tandem.

Status: Pre-monsoon: C, Monsoon: A, Post-monsoon: A.

Subfamily: Ischnurinae

4. ***Aciagrion occidentale* Laidlaw, 1919**

Material examined: 1F; 14.ix.2000.

Field notes: Common during post-monsoon, mixing with *Mortonagrion varralli* among the sedges.

Status: Pre-monsoon: NF, Monsoon: NF, Post monsoon: C.

5. ***Ischnura aurora aurora* (Brauer 1865)**

Material examined: 1M; 1.x.1999. 1M; 14.ix.2000.

Field notes: Common. Observed only during post-monsoon. Mainly found among the sedges lining the aquacultural ponds.

Status: Pre-monsoon: NF, Monsoon: NF, Post-monsoon: C.

6. ***Ischnura senegalensis* (Rambur 1842)**

Material examined: 1F; 18.ii.2000.

Field notes: Common during pre-monsoon.

Status: Pre-monsoon: C, Monsoon: NF, Post-monsoon: NF.

Subfamily: Agriocnemidinae

7. ***Agriocnemis pygmaea* (Rambur 1842)**

Material: 1M; 1.x.1999.

Field notes: Common during post-monsoon. Frequents grasslands on the banks of the swamp.

Status: Pre-monsoon: NF, Monsoon: NF, Post-monsoon: C.

8. ***Mortonagrion varralli* Fraser 1920**

Material examined: 1M; 2.i.2000. 4M; 23.vii.2000. 3M, 2F; 14.ix.2000.

Field notes: Abundant. Found among the littoral vegetation in good numbers towards dusk throughout the survey.

Status: Pre-monsoon: C, Monsoon: C, Post-monsoon: A.

Suborder: Anisoptera
Superfamily: Aeshnoidea
Family: Gomphidae
Subfamily: Lindeniinae

9. ***Ictinogomphus rapax* (Rambur 1842)**

Field notes: Uncommon. Frequents paddy fields, reed beds and other aquatic vegetation during the monsoon and post-monsoon.

Status: Pre-monsoon: NF, Monsoon: UC, Post-monsoon: R.

Family: Libellulidae
Subfamily: Libellulinae

10. ***Orthetrum sabina sabina* (Drury 1770)**

Material examined: 1M; 2.i.2000.

Field notes: Common. Observed throughout the season, hovering over the mangrove vegetation.

Status: Pre-monsoon: C, Monsoon: C, Post-monsoon: C.

Subfamily: Sympetrinae

11. ***Acisoma panorpoides panorpoides* Rambur 1842**

Material examined: 1M; 1.x.1999.

Field notes: Uncommon. A single specimen collected in October from tall *Fimbristylis* grass.

Status: Pre-monsoon: NF, Monsoon: NF, Post-monsoon: UC.

12. ***Brachythemis contaminata* (Fabricius 1793)**

Material examined: 2M, 1F; 1.x.1999; 1F; 14.ix.2000.

Field notes: Commonly observed throughout the study, among the emerging macrophytes of the creeks. Abundant after monsoon.

Status: Pre-monsoon: R, Monsoon: C, Post-monsoon: A.

13. ***Crocothemis servilia servilia* (Drury 1770)**

Material examined: 1M; 1.x.1999.

Field notes: Common. Found throughout the study, except in summer, in and around paddy fields.

Status: Pre-monsoon: R, Monsoon: C, Post-monsoon: C.

14. ***Diplacodes trivialis* (Rambur 1842)**

Material examined: 2M, 2F; 1.x.1999. 1F; 21.vii.2000. 1F; 14.ix.2000.

Field notes: Abundant. Observed throughout the survey along the shoreline vegetation. During July, unusually large numbers of teneral forms were found congregating on the shore. Breeding pairs were seen in July.

Status: Pre-monsoon: UC, Monsoon: A, Post-monsoon: UC.

15. ***Neurothemis tullia tullia* (Drury 1773)**

Field notes: Uncommon. Frequents reed beds and paddy fields, especially during monsoon.

Status: Pre-monsoon: NF, Monsoon: R, Post-monsoon: UC.

Subfamily: Trithemistinae

16. ***Trithemis pallidinervis* (Kirby 1889)**

Material examined: 1M, 2F; 14.x.2000.

Field notes: Abundant during September. Swarms of this species found fluttering around the thickets of grass near aquaculture ponds.

Status: Pre-monsoon: NF, Monsoon: A, Post-monsoon: A.

Subfamily: Trameinae

17. ***Rhyothemis variegata variegata* (Linnaeus 1763)**

Material examined: 1F; 14.ix.2000.

Field Notes: Abundant, swarms active during the post-monsoon. Breeding activities observed during September.

Status: Pre-monsoon: NF, Monsoon: A, Post-monsoon: A.

18. *Pantala flavescens* **(Fabricius 1798)**

Material examined: 1F; 23.vii.2000. 1M; 14.ix.2000.

Field notes: Swarms of this species observed throughout the survey. Activities intense during post-monsoon.

Status: Pre-monsoon: C, Monsoon: UC, Post-monsoon: A.

19. ***Tramea limbata similata*** **Rambur 1842**

Material examined: 1M; 14.ix.2000.

Field notes: Common in September. Found soaring over the wetlands along with *Pantala flavescens*.

Status: Pre-monsoon: NF, Monsoon: C, Post-monsoon: C.

20. ***Tholymis tillarga*** **(Fabricius 1798)**

Material examined: 1F; 1.x.1999, 1M; 21.vii.2000.

Field notes: Observed throughout the survey. Abundant in monsoon. Found patrolling all along the wetland area with great speed and agility towards dusk. Many specimens found hanging on the twigs of *Aegiceras corniculatum* at *c.*1840 hrs on a rainy day.

Status: Pre-monsoon: C, Monsoon: A, Post-monsoon: C.

21. ***Macrodiplax cora*** **(Brauer 1867)**

Material examined: 1M; 1.x.1999.

Field notes: Rare. A single specimen collected immediately after the monsoon.

Status: Pre-monsoon: NF, Monsoon: NF, Post-monsoon: R.

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29. THE PULMONATE SNAIL *OPEAS GRACILE* (HUTTON), STYLOMMATOPHORA: SUBULINIDAE: OPEATINAE — A NEW RECORD FROM JAMMU PROVINCE, JAMMU AND KASHMIR STATE

In the literature on the malacofauna of Jammu Province of Jammu and Kashmir State (Theobald 1878, Verma *et al.* 1996, and Duda *et al.* 1999) the stylommatophore gastropods reported from Jammu Province are: *Ena* (*Subzebrinus*) *arcuatus* Pfeiffer (Family Enidae), *Anadenus altivagus* (Theobald) (Family Arionidae), *Bensonia jammuensis* (Theobald), *B. monticola* (Hutton), *Euanstenia monticola* (Hutton), *Syama splendens* (Hutton) (Family Ariophantidae), *Limax maximus* Ferrusac (Family Limacidae) and *Planispira* sp. (Family Helicidae).

While collecting molluscs of Jammu and Kashmir State, we obtained several specimens of the pulmonate snail *Opeas gracile* (Hutton) (Subulinidae: Opeatinae) from a garden in Roop Nagar on the outskirts of Jammu city. As this species has not been reported from Jammu Province earlier, this is a new record.

Gude (1914) reported *Opeas gracile* (Hutton) from Kashmir without giving its exact distribution in the region. The present report extends the range of the species as well as of the Family Subulinidae to Jammu Province for the first time, as *Opeas gracile* (Hutton) is the sole representative of Subulinidae in this region.

We thank Shri. S.C. Mitra, Asst. Zoologist and Officer-in-Charge, Mollusca Sect., Zoological Soc. of India SI, Kolkata for confirming the identity of the specimen.

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30. EXTENSION OF DISTRIBUTION OF THE THOMISID SPIDER *PLATYTHOMISUS SUDEEPI* BISWAS, THOMISIDAE: ARANEAE, FROM NORTH KANARA, KARNATAKA

Thomisid spiders, commonly known as crab-spiders, have been studied by Tikader (1960-95). His work on the FAUNA OF INDIA, THOMISIDAE (PT. 1) (1980) covers 115 species under 25 genera nominated, so far, from the Indian subcontinent. *Platythomisus sudeepi* Biswas, an uncommon Thomisid spider, was identified on the basis of a fine photograph by Ashok Captain. The identification was made with the keys, descriptions and illustrations from this FAUNA (pp. 172-174).

The type locality for *P. sudeepi* Biswas is Pollibetta, Coorg district, Karnataka (15° 12' N, 75° 80' E). The types (2 ♀ ♀) of this species have been deposited in the National Collection, Zoological Survey of India, Kolkata. The description given in the FAUNA tallies with the photograph, except for the red abdominal colour as against the deep brown, and three conspicuous black bands, which also vary in size and shape. The photograph was taken at Castle Rock, North Kanara, Karnataka near the state border of Goa (14° 28' N, 74° 20' E), *c.* 280-300 km north of the type locality.

The genus *Platythomisus* Dolesch constitutes only two nominated species: *Platythomisus bazarus* Tikader from Nayabazar, West Sikkim and *P. sudeepi* Biswas from Pollibeta, Coorg, Karnataka in India. The present report from North Kanara is the second report of this Indomalayan genus from the Western Ghats and reduces the vast gap between the two earlier records.

The Thomisids are non-orb-weaving jumping spiders that hunt their prey by direct attacks through the foliage and flowers and mainly devour diurnal insects. They move their legs, specially the first two pairs, sideways like crabs; their bodies are also dorsoventrally flattened, due to which they are termed crab-spiders. They usually possess bright and beautiful body colouration (Tikader 1980), which varies greatly even within the same species in the same locality. The body colours in Arachnids depend upon the nature of their food (insects and other invertebrates).

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31. REDESCRIPTION OF *TETRAGNATHA VIRIDORUFA* GRAVELY FROM KERALA, INDIA, ARANEAE: TETRAGNATHIDAE

Tetragnatha viridorufa Gravely, a common species in the forests and paddy fields of Kerala, was first reported by Gravely (1921) from Barkuda Islands, Orissa. As a predominant predatory spider in our agricultural fields, *T. viridorufa* bears much importance in biocontrol studies. However, as there is no detailed illustration in Gravely's description, its identification is usually difficult. During our study on the spiders of Ernakulam district in Kerala, we came across several specimens of *T. viridorufa*. A detailed description and illustration of *T. viridorufa* collected is given here.

Collection and preservation of the spiders was done following Tikader (1987). The material was studied using a Stereozoom binocular microscope, model Leica MS-5. All measurements are in millimetres, made with an eyepiece graticule.

Abbreviations used are as follows: ALE = Anterior lateral eye, AME = Anterior median eye, PLE = Posterior lateral eye, PME = Posterior median eye; Spination: dvpr = dorsal-ventral-prolateral-retrolateral, MOQ = Median ocular quadrangle, L = Length, W = Width, H = Height, SR = Semicircular ridge, TT = Truncate tooth.

Tetragnatha viridorufa Gravely

(Figs 1-19)

1921 *Tetragnatha viridorufa*: Gravely, *Rec. Ind. Mus. 22*: 411 and 434

1987 *Tetragnatha viridorufa*: Tikader, *Handbook of Indian spiders*: 222

Cephalothorax reddish-brown, longer than broad. Abdomen elongate, yellowish-brown in male, dorsum reddish and lateral sides bright greenish in female. Legs longer, slender and yellowish-brown.

Measurements (in mm): **Male**: Total length: 10.75; Cephalothorax 3 L, 1.5 W, 1.0 H; Abdomen 7.6 L, 1.2 W, 1.0 H. **Female**: Total length: 10.40; Cephalothorax 3.2 L, 1.9 W, 1.0 H; Abdomen 7.1 L, 1.7 W, 1.1 H.

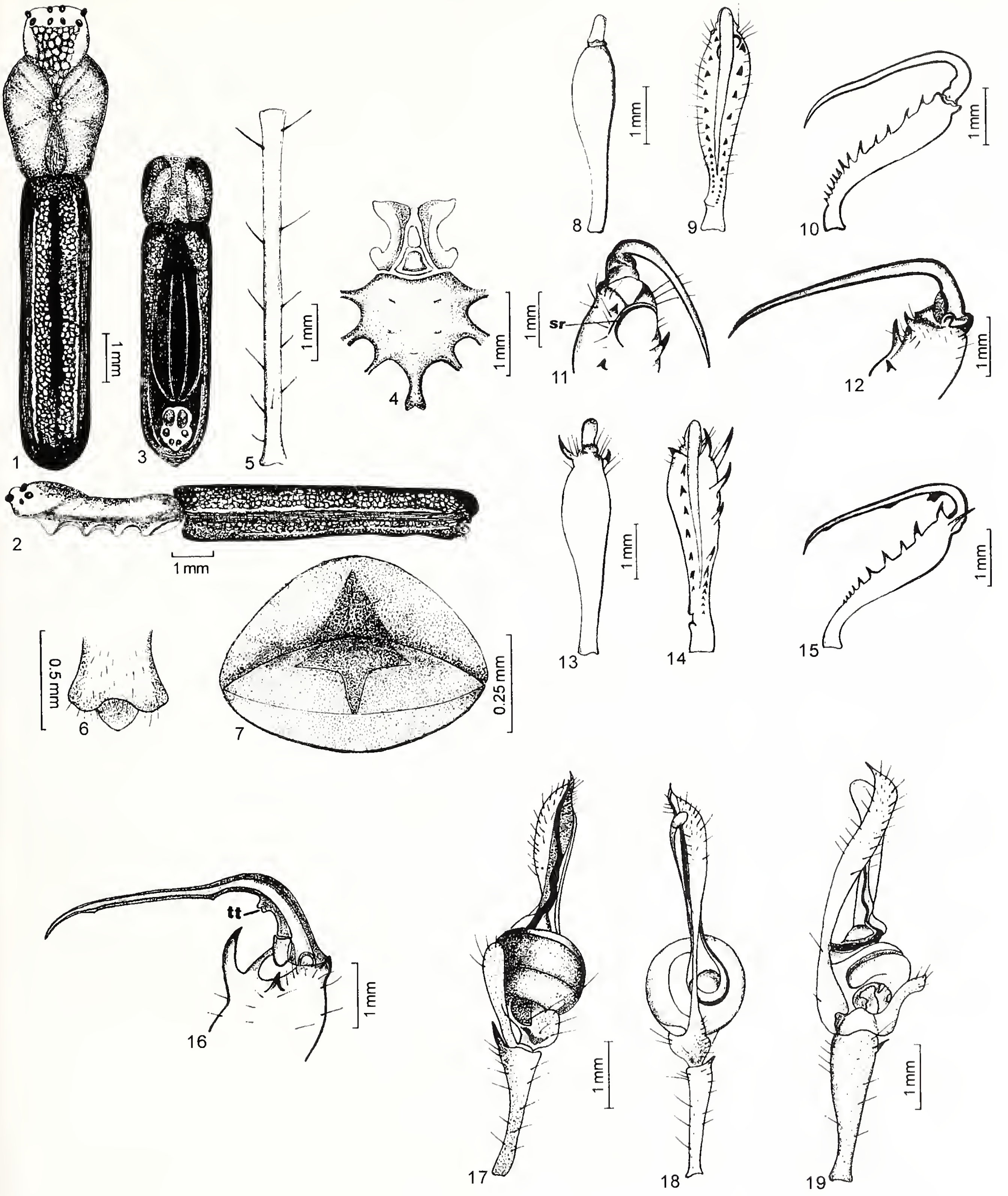
CEPHALOTHORAX

Male: Reddish-brown, longer than broad. Cephalic region rounded anteriorly, broadest basally and slightly concave dorsally. Cephalic region separated from thoracic region by a short indentation. Eyes eight in two rows, both rows recurved, MOQ slightly wider at the anterior end. Anterior eye row longer than posterior. Eye separation AME-AME 0.12, AME-ALE = 0.22, PME-PME = 0.10, PME-PLE = 0.15; Eye diameter AME 0.18, ALE = 0.15, PME = 0.17, PLE = 0.15. Eye row length: AE = 0.98, PE = 0.94. Cheliceral length = 4, fang = 3.2. Sternum, Labium, Maxillae as in female. Chelicerae long, slender and widely divergent; first dorsal spine and subapical spine subequal in length, the former being slightly shorter and thicker than latter and much longer than other spines. Fang armed with a strong truncate tooth on the inner side of the basal bend. Legs yellowish-brown, long and slender. Metatarsus I / Tarsus I = 6.73. Leg formula 1 2 4 3. Palp yellow, bulb transverse; length of the palp longer than femur III, about one half of femur I. Cymbium as long as tibia, broader at the apical half; paracymbium cleft apically, four times longer than broad. Apex of conductor thin and shortly curved upwards. Embolus elongate and thin (Figs 17-19).

Female: Reddish-brown, longer than broad. Fovea distinct and deep, with two lateral furrows converging to it from anterior end. Eyes eight in two rows, both rows recurved, anterior row longer than posterior row. Ocular quadrangle longer than broad, slightly wider at the anterior end. Clypeus height 1.3 times AME diameter. Sternum longer than wide, brownish-yellow, pointed behind. Labium longer than wide, similar in colour to sternum, apical end bluntly rounded, basal end with lateral indentations. Maxillae yellowish-brown, longer than wide; distal end with lateral projections having a longitudinal ridge midventrally (Fig. 4). Chelicerae with 15 teeth on the outer margin and 13 teeth on the inner margin. 7 basal teeth on outer margin and 6 basal teeth on the inner margin are smaller and closely set. Chelicerae long, slender and widely divergent; first dorsal and ventral teeth much larger than others (Figs 8-12). A semicircular ridge extends between first dorsal and ventral spine (Fig. 11). Fang unarmed. Eye diameter ALE = 0.13, AME = 0.15, PLE = 0.13 PME = 0.14. Eye separation ALE-AME = 0.22, AME-AME = 0.13, PME-PLE = 0.18, PME-PME = 0.11, AME-PME = 0.12. Eye row length AE = 1.02, PE = 0.91. Length of ocular quadrangle 0.36. Cheliceral length = 4. Legs longer, slender and yellowish-brown. Leg formula 1 2 4 3. Spination of Tibia I dvpr = 2-2-5-4, Femur I dvpr = 1-2-9-5 (Fig. 5)

ABDOMEN

Male: Abdomen yellowish-brown, elongate and cylindrical. Abdominal tip rounded, not exerted



Figs 1-19: *Tetragnatha viridorufa* Gravely: ♀1. Dorsal view, 2. Lateral view, 3. Abdomen - Ventral view, 4. Sternum with labium and maxillae, 5. Femur I, 6. Epigynal fold, 7. Internal Genitalia, 8. Chelicerae - Dorsal view, 9. Chelicerae - Ventral view, 10. Chelicerae - Lateral view, 11. Chelicerae - Anterior end enlarged - ventral view, 12. Semicircular ridge - Lateral view, 13. ♂ Chelicerae - Dorsal view, 14. ♂ Chelicerae - Ventral view, 15. ♂ Chelicerae - Lateral view, 16. ♂ Chelicerae - Anterior end enlarged - Lateral view, 17. ♂ Palp - Dorsal view, 18. ♂ Palp - Ventral view, 19. ♂ Palp - Lateral view.

Table 1: Measurements in mm for *Tetragnatha viridorufa* Gravely (♂)

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	9.00	1.10	9.30	10.10	1.50	31.00
II	6.05	1.00	5.35	5.75	1.15	19.30
III	3.90	0.72	2.51	2.95	0.89	10.97
IV	7.15	0.71	4.95	5.25	0.91	18.97
Palp	2.1	0.51	1.10	—	1.40	5.11

Table 2: Measurements in mm for *Tetragnatha viridorufa* Gravely (♀)

	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	9.11	1.21	9.20	10.0	2.40	31.92
II	6.52	1.00	6.10	6.81	1.52	21.95
III	4.30	0.72	2.52	3.13	1.12	11.79
IV	7.10	0.68	6.00	6.11	1.50	21.39
Palp	1.51	0.51	1.21	—	1.20	4.43

beyond spinnerets. Lateral margins smooth except three posterotransverse striations near spinnerets. Venter yellowish, book lungs brown, longer than broad. A transverse black patch in front of spinnerets ventrally.

Female: Elongate, dorsum reddish and lateral sides bright greenish. Abdominal tip blackish, slightly projecting beyond spinnerets. Venter yellowish-brown. Epigynal fold short, distal fold wider than long, with a conical tip. (Figs 1-3)

Distribution: India: Villivakulam, Chingleput district; Barkuda island, Ganjam district; Balugaon and Balighai, Puri district, Orissa; Ernakulam, Thattakkad Bird Sanctuary, Bhoothathankettu; Kerala.

Natural History: Nocturnal, collected from coconut leaves hiding under the leaves; colouration of the abdomen helps in concealing its presence.

Material examined: India: 2 ♀♀, ♂, Moolampilly Is., Ernakulam, 26.ii.2001, Habitat: coastal ecosystem, Coll. K. Sunil Jose.

2 ♀♀, 2 ♀♀, Bhoothathankettu, Kothamangalam, 5.xii.2000. Habitat: Evergreen forest, Coll. K. Sunil Jose.

1 ♂, 2 ♀♀, Thattakkad Bird Sanctuary, 10.iv.2001. Habitat: Evergreen forest, Coll. Samson Davis.

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32. ON TWO INTERESTING MARINE CRABS (DECAPODA: BRACHYURA) FROM MANDVI, KUTCH

In connection with studies on animal-sediment relationship, involving burrows made by polychaetes, crustaceans and molluscs, crabs were collected by one of us (BGD) from the intertidal zone around Mandvi region (22° 55' N, 69° 20' E) in the Gulf of Kutch. A total of seven species were collected and identified as follows:

1. *Matuta lunaris* (Forskal), 2. *Matuta planipes* Fabricius, 3. *Portunus tenuipes* (De Haan), 4. *Ocypoda ceratophthalma* (Pallas), 5. *Ocypoda platytarsis* Milne-Edwards, 6. *Ocypoda rotundata* Miers, and 7. *Plagusia depressa* var. *squamosa* (Herbst).

Chhapgar (1957a, b, 1958, 1961, 1968, 1979), Chhapgar and Borgaonkar (1985) and Chhapgar and Mundkur (1995), in studies on marine crabs of the erstwhile Bombay State, had recorded species 1, 2, 4, 6 and 7 from the above list. The other two, namely *Portunus tenuipes* (De Haan) and *Ocypoda platytarsis* Milne-Edwards appear to be new records for the region.

Portunus tenuipes (De Haan)

This is the only Indian species of *Portunus* in which the front is cut into three teeth (all the others have four teeth). The length of the carapace is about two-thirds its breadth. The antero-lateral borders are cut into nine teeth, of which the last is a long spine thrice as long as the other teeth.

The arm of the chelipeds has three spines on its anterior border and one at the far end of the posterior border. There is a strong spine on the inner angle of the wrist, and a much weaker one on the outer angle. The hand has a spine near the wrist-joint and another just behind its joint with the finger.

Alcock's (1899) key states "posterior angles of carapace square" for *P. tenuipes*. His description is: "Posterior border slightly curved and meets the postero-lateral border at a well-marked angle which is sometimes slightly turned up." In the specimen examined by us, the postero-lateral borders appear to continue as a smooth curve with the posterior border. Below this level, however, the front edge of the abdomen does show an acute spiny angle.

In view of the smooth curving of the postero-lateral borders into the posterior border and the distribution of *P. tenuipes* from the Andamans, as given by Alcock, it was first thought unlikely that the crab was *P. tenuipes*. However, the presence of only three teeth on the front is so characteristic of this species that this character, together with the morphological features tallying with Alcock's description as *P. tenuipes*, leads us to identify this crab.

Breadth of carapace (with spines)	59 mm
Breadth of carapace (without spines)	40 mm
Length of carapace	30 mm

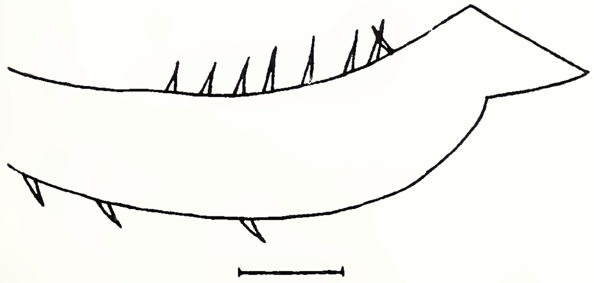

Fig. 1: Tip of first male abdominal appendage of *Ilyoplax gangeticus*

Alcock has not described the colouration of *P. tenuipes*. Our specimen (after prolonged preservation) shows extensive irregular white spots characteristic of *P. pelagicus*, but on a light buff orange background, on the carapace and the arm of the chelipeds. The finger and thumb of both the claws are crimson red along their distal half.

The presence of this species from the Arabian Sea is of interest.

Ocypoda platytarsis Milne-Edwards

This species resembles *O. ceratophthalma*, but differs from it in the absence of brushes of hairs on the anterior surface of the propodites of any of the legs. The dactyli are dorsoventrally compressed and broadened, and are also fluted (Alcock 1900).

The stridulating ridge on the inner surface of the palm is entirely granular. (In *O. ceratophthalma*, this ridge consists of tubercles gradually passing into granules.) The upper edge of the inner surface of the ischium of the large claw, against which the stridulating ridge is rubbed to produce sound, is only raised and rough, there being no specialised structure.

The orbits of the eyes are hardly oblique.

Breadth of carapace: 51 mm

This crab is common along both the coasts of the Indian Peninsula as well as in Sri Lanka.

In the note on *Ilyoplax gangeticus* (Kemp) by Chhapgar and Borgaonkar (1985), description of the first abdominal appendage was inadvertently left out. The tips of the appendages end in a straight edge, somewhat like a ploughshare. Behind this, on one side are about eight close set setae; the other side bears distally spaced setae (Fig. 1).

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33. LITTLE KNOWN BIODIVERSITY OF SUBTERRANEAN FRESHWATER HABITATS IN INDIA, WITH SPECIAL REFERENCE TO CRUSTACEAN FAUNA

The United Nations Convention on Biological Diversity (CBD), which came into force on December 29, 1993, has evoked a tremendous, determined response from the world's scientific community, as well as governments, to save the earth's fast-depleting biodiversity. Though the term biodiversity encompasses the total variability of life in the biosphere, it is often viewed in the restricted sense of epigean flora and fauna, both terrestrial and aquatic. Paradoxically, however, the vast and varied hypogean biodiversity has received little attention, especially in South Asia, including India. This is partly due to the widespread misconception that groundwater is azoic, except for some harmless bacteria.

Elsewhere in the world (see Botosaneanu 1986), however, the hypogean/subterranean biotope has been found to support rich faunal diversity, comprising almost all the free-living invertebrate groups and some vertebrates as well. For example, Pesce (1985), while reviewing the Italian groundwater fauna (stygofauna), met with the following significant stygobiont groups: cyclopid and harpacticoid copepods, ostracods, thermosbaenaceans, mysids, amphipods, isopods, syncarids, decapods, water mites, nematodes, gastropods, tricladid turbellarians, and amphipods. Other groups of organisms that are mostly stygoxenous or stygophilous, include Bacteria, Protozoa, Rotifera, Cladocera, Archiannelida, Oligochaeta, Gastrotricha, Bivalvia, and insect larvae. Further, the subterranean environment may reveal insights into biological adaptation and speciation (Barr 1968, Rouch 1986). Even the reconstruction of the earth's history is interpreted in terms of the occurrence of certain ancient stygofaunal elements (Schminke 1974, 1981).

In India, the faunal diversity of the subterranean freshwater biotope, i.e. Husmann's (1971) 'kernel zone' of groundwater, has received scant attention from taxonomists and systematists. Hence, this note is meant to update the poorly known Indian stygocrustacean fauna, and to underscore the need to start highly rewarding stygobiological research in the country.

Two methods were used to collect the animals from the subterranean freshwaters:

Direct filtration: Bore-well water was filtered for 3 to 4 hrs by tying a plankton net made of bolting silk (mesh size 70 µm) to the inlet delivery tube of overhead storage tanks in residential areas or by manually holding the net against water pumped from agricultural bore wells for *c.* 30 min. The filtrate was fixed in 10% formalin and preserved in 5% formalin solution.

Coring and filtration: Plastic tubes (open at both ends) 70 cm long and 4 cm wide, and/or metal corer, were employed in sandy or gravelly hyporheic zones of rivers. The cores taken from the sediment surface to a depth of 10-30 cm were pooled into a bucket and vigorously stirred with filtered habitat water. The supernatant was filtered through plankton net, and the filtrate fixed and preserved as mentioned above. Other details such as dissection, and drawing, are as given in Reddy (2001).

Checklist of the known Stygocrustaceans in India

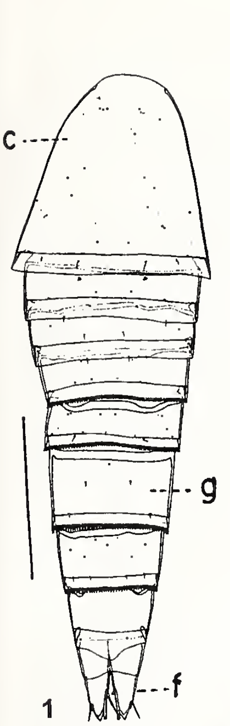
Amphipoda

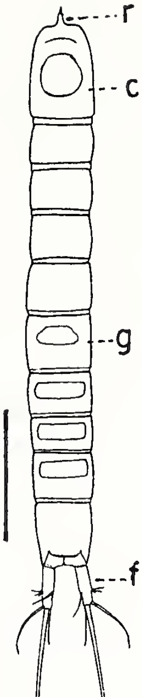
Indoniphargus indicus (Chilton 1923) appears to be the first record of a true stygobiont, freshwater crustacean in India; it was found in wells, springs and mine pits in Bengal, Orissa, and Bihar (Botosaneanu 1986). No further amphipod species are known from the subterranean freshwater in India to date.

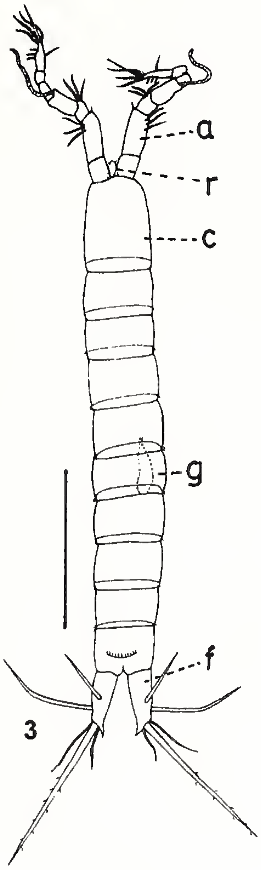
Isopoda

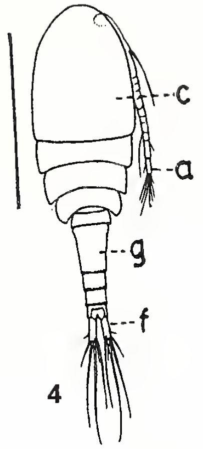
Nichollsia kashiense Chopra & Tiwari 1950 (Fig. 7): Wells at Benaras and Lahagara in Uttar Pradesh.

Nichollsia menoni Tiwari, 1955: Well at Monghyr in Bihar.

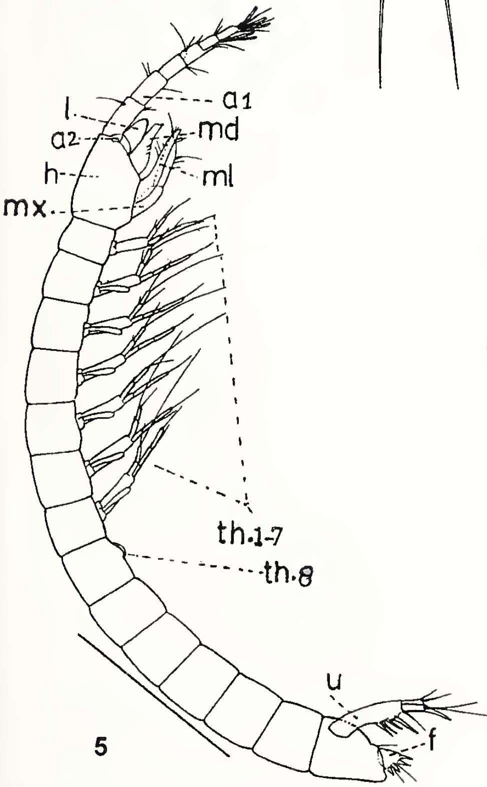


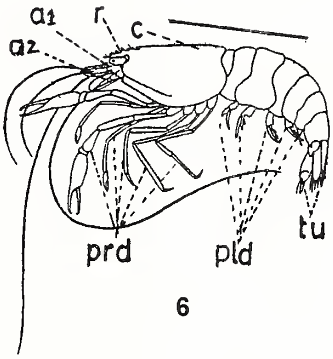


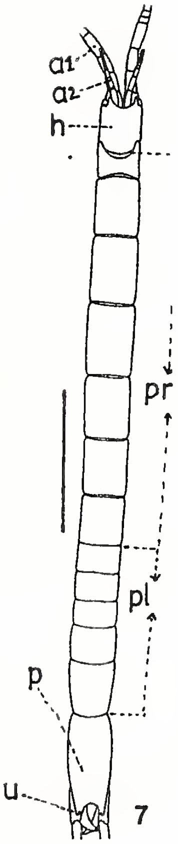


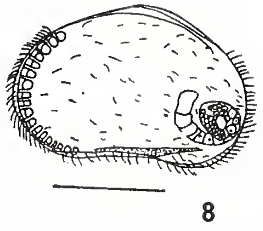


Figs 1-4: Some copepod representatives of the subterranean freshwater in India: 1. *Rangabradya indica*, female, dorsal, scale = 0.1 mm; 2. *Parastenocaris gayatri*, male, dorsal, scale = 0.1 mm; 3. *Leptastacus* n. sp., male, dorsal (original), scale = 0.1 mm; 4. *Thermocyclops oblongatus*, female, dorsal, scale = 0.5 mm. Abbreviations: a = antennule; c = cephalothorax; f = caudal furca; g = genital somite; r = rostrum.









Figs 5-8: Some non-copepod crustaceans of the subterranean freshwater in India: 5. *Habrobathynella schminkei*, female, lateral, scale = 0.2 mm; 6. *Troglindicus phreaticus*, male, lateral, scale = 0.5 mm; 7. *Nichollsia kashiense*, male, dorsal, scale = 5.0 mm; 8. *Cypretta fontinalis*, female, left valve, dorsal, scale = 0.3 mm. Abbreviations: al = antennule; a2 = antenna; c = cephalothorax; f = furca; h = head; l = labrum; m = mandible; ml = maxillule; mx = maxilla; p = pleotelson; pl = pleon; pr = preon; prd = pereopods; pld = pleopods; th. 1-7 = thoracopods 1-7; th. 8 = thoracopod 8; u = uropod.

Decapoda

Macrobrachium cavernicola (Kemp 1924): Streams and pools in Siju Cave, Garo Hills, and a cave near Cherrapunji, Meghalaya (Kemp 1924).

Troglindicus phreaticus Sankolli & Shenoy, 1979 (Fig. 6): Fort Well near All-weather Port, Ratnagiri, Maharashtra (Sankolli and Shenoy 1979).

Mysidacea (from Botosaneanu 1986)

Spelaeomysis longipes (Pillai and Mariamma 1963): well at Kottayam, Kerala.

Ostracoda (from Botosaneanu 1986)

Cypretta fontinalis Hartmann 1964 (Fig. 8): Well at Junagadh, Gujarat (Vicror and Fernando 1978).

Copepoda

Cyclopid and harpacticoid copepods represent a very significant and highly speciose crustacean group in subterranean freshwaters as in epigean waters. During a survey of the Indian stygofauna, conducted by the Zoological Institute of the University of L'Aquila, Italy (December 1982 to January 1983), Pesce and Pace (1984) recorded for the first time four cyclopid species in freshwater wells near New Delhi: *Thermocyclops oblongatus* (G.O. Sars 1927) (Fig. 4), *Eucyclops serrulatus* (Fischer 1851), *Mesocyclops aspericornis* (Daday 1906), and *Tropocyclops prasinus* (Fischer 1860).

As for the harpacticoids, *Elaphoidella crassa* Chappuis 1954 is the first subterranean freshwater taxon in India; it was reported from Maosmae cave near Cherrapunji by Chappuis (1954). Karanovic and Pesce (2001) have described a second species, *Rangabradya indica* Karanovic and Pesce 2001 (Fig. 1), from a freshwater well at Guntur.

Bathynellacea

The order Bathynellacea, which contains primitive and very ancient freshwater syncarid crustaceans (ancestry dating back to the Carboniferous or even earlier; see Schminke 1974), has been reported by Reddy (in press, a) for the first time in South Asia. Reddy (in press, b) has also discovered a eustygobiont parabathynellid, *Habrobathynella nagarjunai* Reddy, in a well on the Nagarjuna University campus, Guntur.

Paradoxically, the vast interstitial, hyporheic zone of the Indian streams and rivers, which is but an extension of the subterranean freshwater biotope (stygobion), has remained practically unexplored till now, as confirmed by G.C. Rao (pers. comm.), a noted marine meiobenthologist in India. Reddy (2001, in press, a) has recorded in three peninsular rivers, i.e. Krishna, Godavari, and Pennar, ten harpacticoid and two bathynellacean species, seven of which are new to science:

Copepoda Harpacticoida

Parastenocaris gayatri Reddy 2001 (Fig. 2)
Parastenocaris savita Reddy 2001
Parastenocaris sandhya Reddy 2001
Parastenocaris curvispinus Enckell 1970
Parastenocaris n. sp.
Leptastacus n. sp. (Fig. 3)
Mesochra wolskii Jakubisiak 1933
Nitokra lacustris (Schmankevitsch 1875)
Cletocamptus deitersi (Richard 1897)
Onychocamptus mohammed (Blanchard & Richard 1891)

Syncarida Bathynellacea

Habrobathynella schminkei Reddy (Fig. 5)
Habrobathynella n. sp.

With its highly diversified geomorphology, hydrography, and climate, the Indian subterranean freshwater biotope is quite likely to support rich faunal diversity as elsewhere, and thus holds enormous serendipitous potential for taxonomists and systematists. (Literally, specimens of many groundwater taxa, which are not yet known to science, are being continually consumed by man through raw water, or let into the sewers.) Considering that this special habitat has already become endangered owing, *inter alia*, to overexploitation and pollution of the water table, the national funding agencies would do well to encourage scientists to unearth the stygofaunal diversity in the country and delve into its adaptational biology. Stygobiology deserves to be treated as a distinct branch of science.

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34. *HYPERICUM GAITII* HAINES (HYPERICACEAE), A NEW RECORD FOR SOUTHERN PENINSULAR INDIA

The genus *Hypericum* with about 400 species is cosmopolitan in distribution. 25 species of the genus have been reported from India (Sharma and Sanjappa 1993), of which 5 species are so far known to occur in southern peninsular India.

While working on the flora of Eastern Ghats, we collected an interesting species of *Hypericum* from the slopes of Galikonda hills of Visakhapatnam district, Andhra Pradesh. After critical study it was identified as *Hypericum gaitii* Haines and found to be a new record for southern peninsular India. This taxon has not been reported so far from Andhra Pradesh (Pullaiah and Chennaiah 1997). With this report, its distribution extends from east to south. A detailed description and illustration of this species is provided here.

Hypericum gaitii Haines in J. Asiat. Soc. Beng. n.s. 15: 311. 1919 & Bot. Bihar & Orissa 1: 52.1925. Saxena & Brahmam Fl. Orissa 1: 111-112. 1994. Sharma & Sanjappa Fl. India 3: 58 f. 59.1997.

Much branched glabrous shrub, 0.8-2 m tall; stem chartaceous, terete, reddish brown, internodes long, conspicuous. Leaves simple, opposite, decussate, elliptic-oblong, to oblong-lanceolate, rarely oblanceolate, 1.5-6 x 0.3-1.8 cm, glabrous, pale and black glandular beneath, apex subacute to acute, margin entire, base sub amplexicaul, midnerve and lateral nerves reddish-brown, lateral nerves 3 pairs, basal lateral nerves running towards apex, petiole 0. Flowers yellow, bisexual, 2-5 in dichotomous cymes, 2-3.5 cm across, pedicel 7-12 mm long; bracts elliptic-lanceolate, up to 11 mm long. Sepals 5, green, free, imbricate, 8-10 x 4-6 mm, ovate or ovate-lanceolate, persistent in fruit. Petals obliquely obovate, 3 x 1.7 cm, prominently veined, black-glandular punctate, distantly serrulate. Stamens numerous, combined into 5 bunches, *c.* 25 each, epipetalous; filaments linear, 5 to 1.8 cm long, anthers yellow, 1 mm long. Ovary glabrous, ellipsoid, 7 mm long, 5- to 7-locular, broadly oblong, ovules many per locule on axile placentation; styles 5, rarely 6-7, 1.2 cm long, basally connate, persistent; stigma capitate. Capsule ellipsoid or conical, dehiscing along placenta, 1.2-1.5 cm long, tipped with persistent style; seeds numerous, brown, polished, 0.1 mm long, linear to oblong, acute to subacute at both ends, scalariform reticulate.

Fl.: February-May,

Fr: April-June.

Ecology: Rare on slopes of exposed hills.

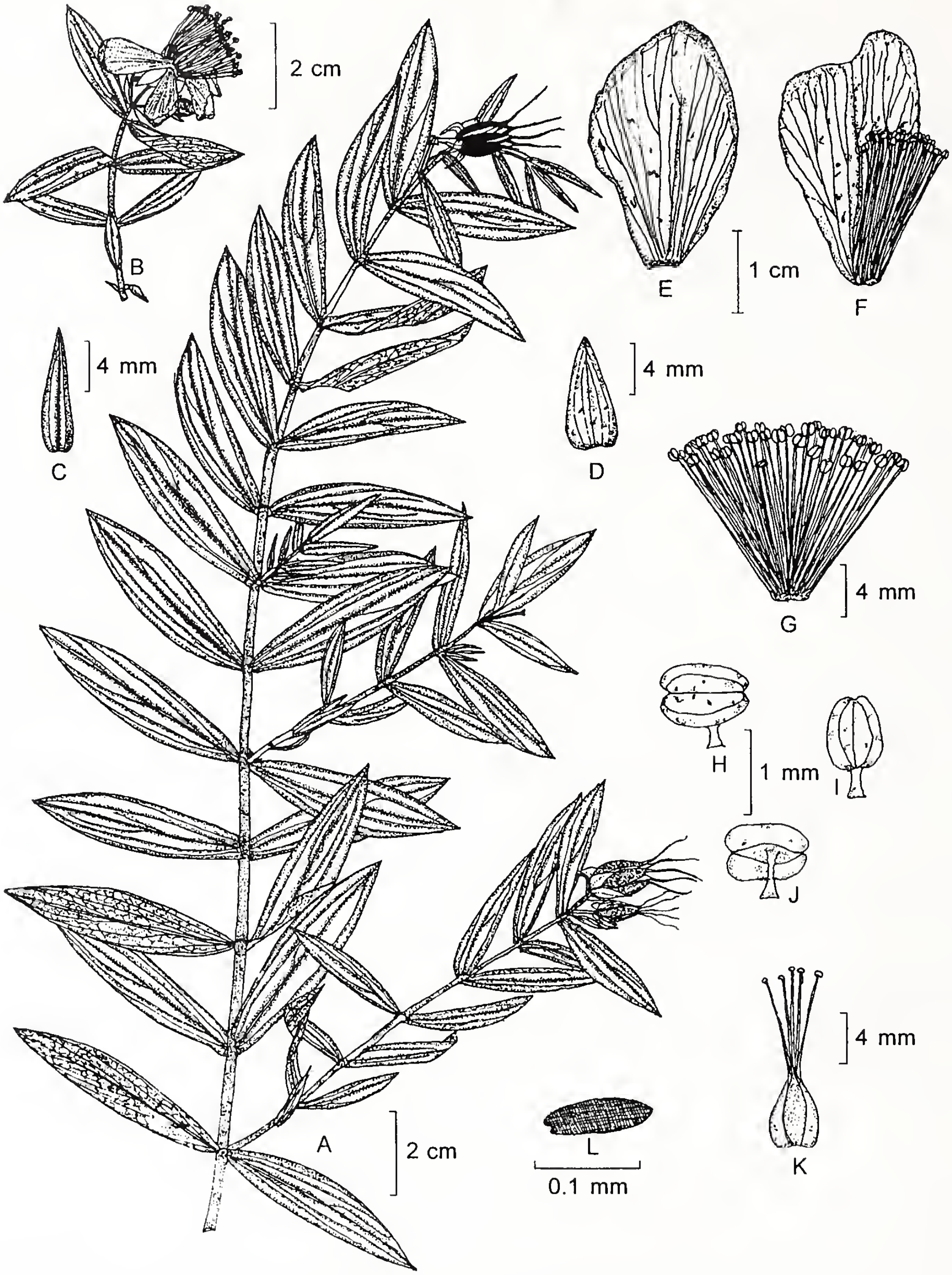

Fig. 1: *Hypericum gaitii* Haines, A. Fruiting twig, B. Flowering twig, C. Bract, D. Sepal, E. Petal, F. Petal with staminal bundle, G. One staminal bunch, H. I. & J. Anthers, K. Pistil, L. Seed.

Specimens examined: Galikonda hills *c.* 1,250 m above msl, Visakhapatnam district, Andhra Pradesh, KSM 21945 & 21956

Distribution: Bihar, Orissa, Andhra Pradesh and Madhya Pradesh - endemic.

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35. AMENDMENT TO AN ENDEMIC SPECIES *DALBERGIA TINNEVELLIENSIS* THOTH., FAMILY FABACEAE ON ITS REDISCOVERY FROM KALAKKAD-MUNDANTHURAI TIGER RESERVE, INDIA

Thothathri (1976) described *Dalbergia tinnevelliensis* sp. nov. from a fruiting specimen collected by Fischer in January 1917 (4045, CAL) from Mundanthurai, Tirunelveli district. This species is endemic to Tamil Nadu (Thothathri 1987). During the inventory in the buffer zone of the Kalakkad-Mundanthurai Tiger Reserve (KMTR), specimens of the species were collected in flowering and fruiting condition after a lapse of about 83 years. The description has been amended on the basis of these new collections. Illustration and other related details are provided to facilitate identification and conservation of the species.

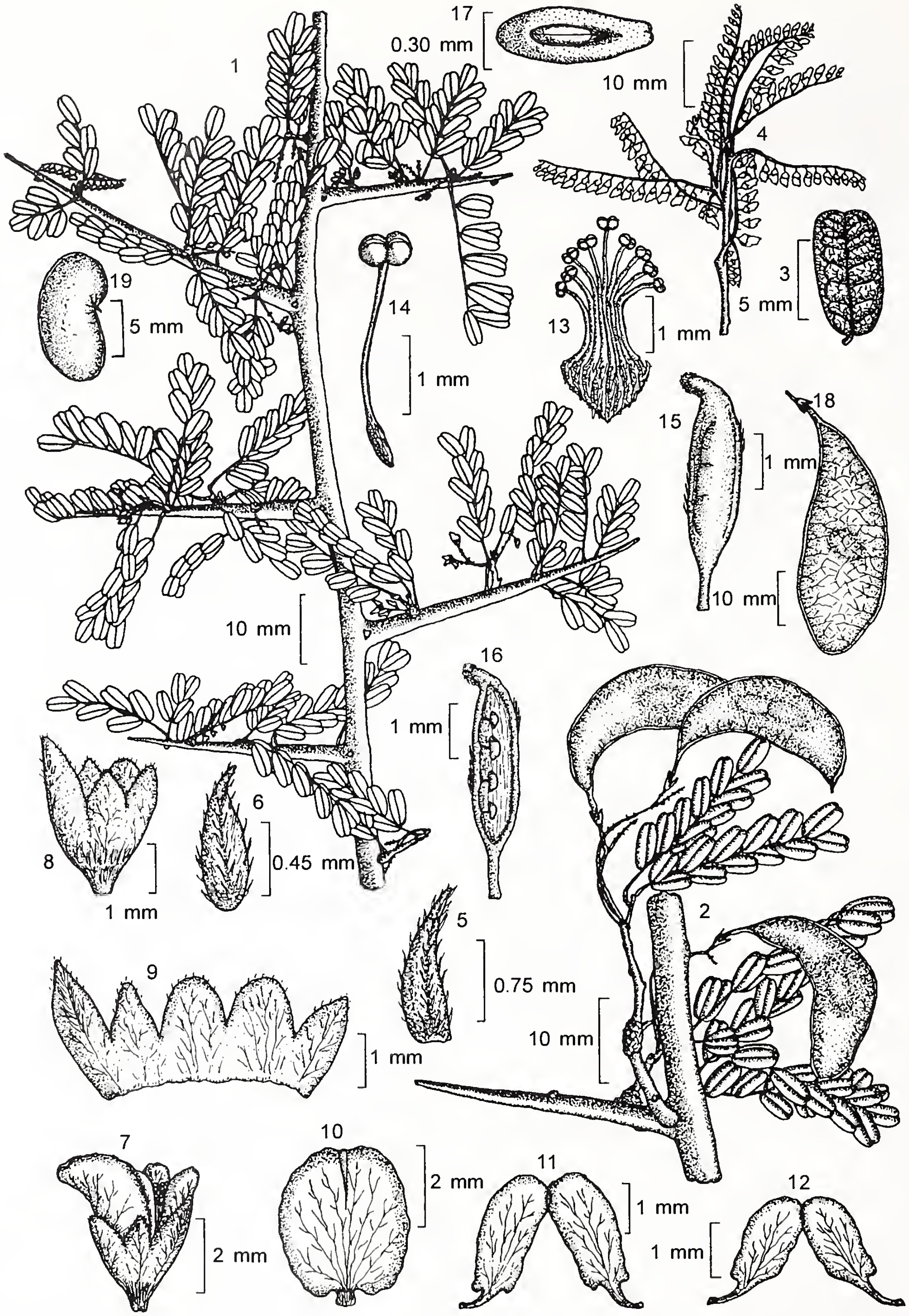
Dalbergia tinnevelliensis Thoth. in Ceylon J. Sci. (Bio. Sci.) 12(1): 47. 1976

Shrub or tree, up to 5 m high; stems woody, lenticellate, glabrous; branchlets rigid, ending in thorns; thorns 0.6-1.7 x 0.15-0.2 cm, glabrous. Leaves alternate, imparipinnate, 2.5-12.6 x 1-4 cm, in short clusters, stipulate; stipules caducous; leaflets 7-17 in each pinna, obovate, 1-2.7 x 0.5-1.3 cm, acutely obtuse at base when young, cuneately obtuse at base when mature, entire at margin, obtusely retuse or emarginate at apex, subcoriaceous, pale green above, glaucous beneath; rachis puberulous; midvein prominent; lateral veins indistinct; petiolules *c.* 1.0 x 0.6 mm, puberulous. Inflorescence in axillary racemose panicles, 1.5-2.5 x 1.7-2 cm. Flowers bisexual, 5-merous, zygomorphic, 4-4.3 x 3.7-3.9 mm; bracts oblong-lanceolate, *c.* 1.5 x 0.3 mm, puberulous outside, glabrous inside; bracteoles lanceolate, *c.* 0.9 x 0.3 mm, puberulous outside, glabrous within; pedicels *c.* 1.2 x 0.3 mm, puberulous. Calyx campanulate, brown, connate at base, 5-toothed above, glabrous, ciliate above middle; tube *c.* 2.0 x 1.5 mm; teeth unequal, upper 4 smaller, lower one larger; upper ones ovate, *c.* 1.1 x 0.9 mm, entire at margin, 2 teeth obtuse at apex, 2 teeth acute at apex; larger one oblong-lanceolate, entire at margin, acute at apex, hairy on midrib outside, *c.* 1.3 x 0.4 mm. Petals 5, whitish yellow; standard orbicular, 3.5-4.1 x 3.2-3.8 mm, slightly auricled at base, entire at margin, retuse at apex; wings 2, oblong, 2.8-3 x 1-1.1 mm, adnate above, auricled at base, entire at margin, obtuse at apex; claw *c.* 0.5 x 0.2 mm; keels 2, oblong-obovate, 2.5-3 x 1-1.2 mm, obliquely auricled at base, entire at margin, adnate above, obtuse at apex; claw 0.5-0.7 x 0.2-0.25 mm. Stamens 9, monadelphous, whitish yellow; staminal column free above, connate up to 1.2 x 1.2 mm; middle one longer, *c.* 1.5 x 0.2 mm; laterals 4, 2 each on either side, *c.* 1.2 x 0.2 mm; marginals 4, shorter than laterals, 2 each on either side, *c.* 1 x 0.2 mm; anthers basifixed, rectangular in shape, *c.* 0.25 x 0.5 mm, transverse. Ovary brown, stipitate, oblong, *c.* 3.25 x 1 mm; stipe *c.* 1 x 0.4 mm; ovules 4; style *c.* 0.35 x 0.25 mm; stigma terminal. Pod greenish - pale brown, indehiscent, flat, oblong-elliptic, 3.6-5.9 x 1.2-1.7 cm, acutely cuneate at base, entire and ribbed at margin, obtusely acute and rarely mucronate at apex, faintly reticulate, glabrous, 1- or 2-seeded, stipitate; stipe 2-5.2 x 0.4-0.8 mm. Seeds 1 or 2, attached marginally, pale to dark brown when mature, reniform, 12.5-12.8 x 6.6-6.9 mm.

The distinguishing features between *Dalbergia coromandeliana* Prain and *D. tinnevelliensis* Thoth. are given in Table 1.

Specimens examined: India, Tamil Nadu, Tirunelveli district, Kalakkad-Mundanthurai Tiger Reserve (KMTR): Ambasamudram Range, Singampatti beat, *c.* 250 m: 9.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10336 & 10384; 10.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10430; 15.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10459; 16.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10514; 17.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10569; 19.iii.2001, M.B. Viswanathan and S. Ramakrishnan 10589; 3.iv.2001, M.B. Viswanathan and M. Venkatesan 12470; 8.v.2001, M.B. Viswanathan and M. Venkatesan 13540; Kadayam Range, Ambur beat: *c.* 240 m: 24.iv.2001, M.B. Viswanathan and S. Ramakrishnan 13105; Kalakkad Range, Kalakkad beat, *c.* 300 m: 9.iii.2001, M.B. Viswanathan and B. Jeyasuresh 10055 & 10079; 18.iii.2001, M.B. Viswanathan and B. Jeyasuresh 10087; 21.iii.2001, M.B. Viswanathan and B. Jeyasuresh 10726; 8.iv.2001, M.B. Viswanathan and B. Jeyasuresh 10769; Papanasam Range, Aladiyur beat, *c.* 200 m: 16.iii.2001, M.B. Viswanathan and N. Andal 10692.

Habitat: Southern tropical thorn forest with trees of *Allophylus serratus*, *Grewia rhamnifolia*, *Sapindus*


17
0.30 mm
1
10 mm
4
19
5 mm
14
13
1 mm
3
5 mm
1 mm
15
18
1 mm
10 mm
10 mm
16
1 mm
8
6
0.45 mm
1 mm
5
2
9
0.75 mm
10 mm
1 mm
7
10
2 mm
11
1 mm
12
2 mm
1 mm

Figs. 1-19: *Dalbergia tinnevelliensis*: 1. A flowering twig; 2. A fruiting twig; 3. Leaflet; 4. Inflorescence; 5. Bract; 6. Bracteole; 7. Flower; 8. Clayx; 9. Calyx split open; 10. Standard; 11. Wings; 12. Keels; 13. Staminal column; 14. Stamen; 15. Ovary; 16. L.S. of Ovary; 17. C.S. of Ovary; 18. Pod; and 19 Seed

emarginatus and *Zizyphus xylopyrus*, shrubs like *Canthium parviflorum*, *Capparis grandiflora*, *Dichrostachys cinerea*, *Osyris quadripartita*, *Securinega leucopyrus* and *Zizyphus oenoplia*, herbs such as *Adiantum incisum*, *Aristida setacea*, *Justicia glauca*, *Barleria prionitis*, *Boerhavia diffusa*, *Commelina benghalensis*, *C. longifolia*, *Cyperus kyllinga*, *Digitaria setigera*, *Evolvulus alsinoides*, *Malvastrum coromandelianum*, *Mollugo pentaphylla* and *Orthosiphon thymiflorus*, and climbers *Argyreia*

Table 1: Distinguishing features between *Dalbergia coromandeliana* and *D. tinnevelliensis*

Characters	*D. coromandeliana* Prain	*D. tinnevelliensis* Thoth.
Habit	Shrub	Shrub or Tree
Lenticels	Absent	Present
Leaves	4-9 cm long, on tubercles	3-12.6 cm long, in clusters
Leaflets	7-11, rarely up to 13, elliptic or cuneate-oblong, 0.6-0.9 cm long, rounded to cuneate at base, obtuse at apex	7-17, obovate, 1-2.7 cm long, acutely obtuse or cuneately obtuse at base, obtusely retuse or emarginate at apex
Petiolules	*c.* 0.5 mm long	*c.* 1 mm long
Inflorescence	Cymose panicles, 2.0-3.5 cm long	Racemose panicles, 1.5-2.5 cm long
Flowers	White to yellow	Whitish yellow
Bracts	Lanceolate	Oblong-lanceolate
Bracteoles	Ovate	Lanceolate
Pedicels	1.5-2 mm long	1-1.2 mm long
Upper 4 calyx lobes	Obtuse at apex, glabrous	2 lobes obtuse and 2 lobes acute at apex, ciliate above middle
Lower calyx lobe	Lanceolate, glabrous	Oblong-lanceolate, ciliate above middle
Standard	Ovate-orbicular to obovate, retuse to emarginate at apex	Orbicular, retuse at apex
Keel	Oblong	Oblong-obovate
Ovary	2-2.5 mm long, glabrous on ventral suture	4.5-5 mm long, puberulous on upper part of ventral suture
Ovules	2-3	4
Pod	Ovate-oblong, 1.7-3.8 cm long, narrowed at base, subacute to acute at apex	Oblong-elliptic, 3.6-5.9 cm long, acutely cuneate at base, obtusely acute and rarely mucronate at apex
Reticulation against seed portion	Distinct	Faint
Seeds	1	1, rarely 2

hirsuta, *Cocculus hirsutus* and *Jasminum angustifolium* var. *sessiliflorum*. In some areas, thickets formed by this species can be seen with sporadic presence of the parasitic *Dendrophthoe falcata*, Family Loranthaceae, on its branches.

Note: Thothathri (1976) opined that branchlets have a tendency to form axillary thorns, whereas all the specimens examined by us had the branchlets ends transformed into thorns.

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36. TWO DISTRIBUTIONAL RECORDS OF CAESALPINIACEAE FOR TAMIL NADU

During a botanical exploration on Tirunelveli hills and the adjoining regions, the authors collected interesting specimens of genus *Caesalpinia* L. and *Cassia* L. (Caesalpiniaceae).

Study of the literature confirmed the specimens as *Caesalpinia major* (Medik.) Dandy & Exell and *Cassia sericea* Sw. The identification was confirmed by the Botanical Survey of India, Coimbatore. So far, they are not recorded from Tamil Nadu, so this constitutes a first record for the state. The nomenclature, diagnostic features, phenology, collection site, field numbers and distribution of the taxa have been provided. The voucher specimens have been deposited in St. Xavier's College Herbarium (XCH), St. Xavier's College, Palayamkottai.

Caesalpinia major (Medik) Dandy & Exell, J. Bot. 76.180.1938; Fosberg, Taxon 22: 162.1793; Halltink, Reinwardtia 9:39. 1974; Verdecourt, Man. New Guinea Legum. 26.1979; Rudd in Dassanayake & Fosberg, Rev. Handb. Fl. Ceylon. 7:49.1991. Bennet, Nam. Cha. Flow. Pl. India and Adj. Regions, 88. 1987. *Guilandina bonduc* L. Sp. Pl. ed. 2, I: 545. 1762, Pro-parte non, L., 1753. *Bonduc majus* Medik., Theod. Spec. 43, t.3, Sup. 1786, excl. syn. L. Type: *Frutex globulorum* Rumph., Herb. Amboin. 5:89, t.48. 1747. *Caesalpinia bonduc* sensu auct. Roxb. Fl. India 2: 362. 1832, non *Guilandina bonduc* L. 1753; Baker in Hook. f., Fl. Brit. India 2: 255. 1878; *Guilandina major* (DC.) Small, Fl. Southeast U.S. 591, 1331. 1903; Skeels, Science, New Ser. 37: 922. 1913. *Caesalpinia globurum* (sic) Bakh. f. & Van Royen, Blumea 12: 62. 1963; Backer & Bakh. f., Fl. Java 1: 545. 1963. *C. jayabo* Maza. ex Merr. In Interp. Herb. Amb. 261; Gamble, Fl. Pres. Madras 1: 394. 1997. (reprint).

Armed stragglers; branchlets pubescent, recurved prickles. Leaves alternate, imparipinnate; leaflets 6-8 pairs, opposite, elliptic-ovate, 6-11 x 3.5 cm, membranous, glossy, glabrous except midrib, sub-sessile. Flowers yellow in axillary simple/rarely branched racemes. Calyx gibbous, brown. Ovules 2-4, parietal. Style included. Pod obovoid, prickled, beaked at apex. Seeds 1-3.

Fl. & Fr: August-November.

Specimens Examined: Tamil Nadu, Tirunelveli district, Karayar, Manickam, 16910, 17153 (XCH).

Remarks: Occasionally found in the moist deciduous forests.

Distribution: India (Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Maharashtra), Sri Lanka, Malay Islands, Polynesia, West Indies.

Cassia sericea Sw., Fl. Ind. Occ. 2(l): 274.1798; Griseb. Fl. Brit. W. Indies. Ib.3: 209.1860; Singh, Bull. Bot. Surv. India 21: 203.1981; Saldanha, Fl. Karnataka 1:386.1984.

Subshrub to 1 m; branchlets pubescent. Leaves alternate, paripinnate; leaflets 3-4 pairs, ovate-oblong, 2-4 x 1-2.5 cm, pubescent, apex apiculate. Flowers yellow, in axillary short racemes. Sepals free, obovate. Antheriferous stamens 7. Pod flat, 4 cm long. Seeds 7-9.

Fl. & Fr.: November-January.

Specimens Examined: Tamil Nadu, Tirunelveli district, Palayamkottai, near N.G.O. 'B' Colony, Murugan 20495 (XCH)

Remarks: Occasionally found along the roadsides.

Distribution: Native of tropical South America, naturalising in Tamil Nadu, Karnataka and Maharashtra states of India.

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37. *CHIONANTHUS RAMIFLORUS* ROXB. VAR. *PENINSULARIS* RAVIKUMAR & LAKSHMANAN, AN EXTENDED DISTRIBUTION TO ANDAMAN & NICOBAR ISLANDS

The genus *Chionanthus* L., Family Oleaceae, is primarily tropical, with a few species in temperate China and North America. In India, it is represented by 10 species (Srivastava and Kapoor 1991).

During the study of the herbarium specimens deposited in PBL, a sheet of *Chionanthus ramiflorus* Roxb. with notes "particularly large fruit" written by Ruth Kiew was found. On further scrutiny, it was identified as *C. ramiflorus* var. *peninsularis* Ravikumar & Lakshmanan which is so far known to occur along streams of evergreen forests and sholas in the Western Ghats (Ravikumar and Lakshmanan 1989). Hence, this is a case of extended distribution in India from the Western Ghats to the Andaman and Nicobar Islands.

A brief description and illustration is provided to enable identification of this species.

Chionanthus ramiflorus Roxb. var. ***peninsularis*** Ravikumar et Lakshmanan Bull. Bot. Surv. India, 31(1-4): 163. 1989.

Trees. Leaves elliptic or elliptic-lanceolate, cuneate at base, acute or shortly acuminate at apex, 2.5-1.3 x 1.2-6 cm., entire to undulate along margins, coriaceous, glabrous, light green above, pale green beneath; lateral veins 8-12 pairs; petiole 1-3.5 cm., glabrous. Infructescence 11-14 cm long, stout. Fruits ellipsoid, oblique, acute to short acuminate at apex, 3-3.5 x 1.4-1.7 cm, smooth, glossy green when young, brownish-black when mature. Seeds 1-2 in number; stalk 4-8 mm long, stout, jointed.

Specimen examined: North Nicobar, Car Nicobar, Tee Top, Sea level, 25.ii.1976, N.G. Nair 3534 (PBL).

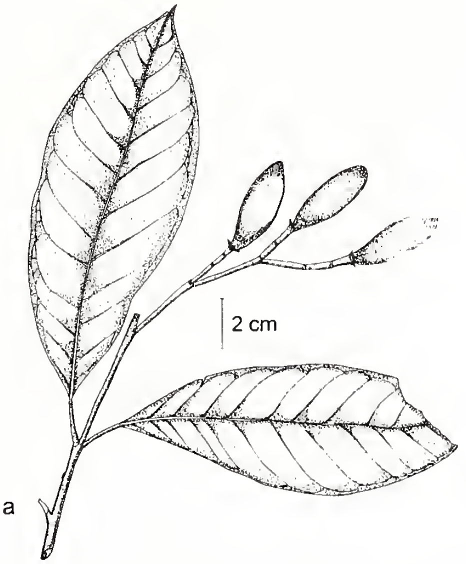

Fig. 1: *Chionanthus ramiflorus* Roxb. var. *peninsularis* Ravikumar & Lakshmanan, a. Habit

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Srivastava, S.K. & S.L. Kapoor (1991): *Chionanthus* Linn. (Oleaceae) in India. *J. Econ. Tax. Bot. 15(1)*: 129-141.

38. *THOTTEA PAUCIFIDA* DING HOU, FAMILY ARISTOLOCHIACEAE, A NEW RECORD FOR INDIA

Thottea is an Indo-Malayan genus with distinctive leaf architecture. It is chiefly distributed in shady places of tropical low land forests. About 26 species have been reported worldwide of which 4 occur in India (Ding Hou in Fl. Malesiana 10: 73. 1984). In Andaman and Nicobar Islands, it is represented by a single species *Thottea tomentosa* (Bl.) Ding Hou. (Vasudeva Rao 1986, Mathew 1988.)

An unidentified species of *Thottea* collected from Rutland of South Andaman was found deposited in PBL.

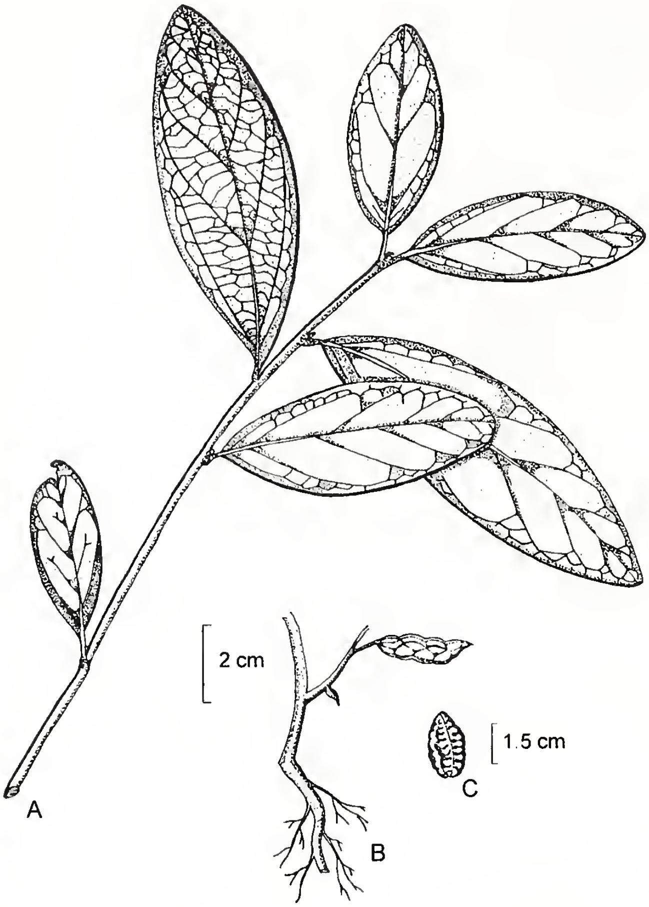

Fig. 1: Thottea paucifida, A. Habit, B. Twig with capsule, C. Seed

The species was later identified as *Thottea paucifida* Ding Hou; earlier know to occur in Borneo. Ding Hou in his revision of Family Aristolochiaceae states that it has been collected just once from the banks of a stream flowing through stands of Rubber and other trees.

This species is reported for the first time in India from the Andaman and Nicobar Islands. A brief description and illustration is provided for identification.

Thottea paucifida Ding Hou, Blumea 27: 324. 1981; Flora Malesiana 10: 73. 1984.

Undershrubs. Leaves alternate coriaceous, elliptic to slightly obovate, 4-10 x 2-4.5 cm, cuneate, obtuse to slightly cordate at base, margin entire, apex acute to obtuse, densely villous below, glabrous above. Basal nerves 3; lateral nerves 4-5 pairs, elevated below, reticulate, obscure above. Petiole *c.* 3.5 mm long, angular, twisted at apex, glabrous. Seeds ellipsoid, *c.* 3 x 1.5 mm, transversely rugose.

Note: Ding Hou in his revision states "Capsules Unknown". Capsules and seeds are described here for the first time.

Specimen examined: South Andaman, Rutland, 19.vii.1986. J.L. Ellis, 12305 (PBL).

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39. *JUNCUS SPUMOSUS* NOLTIE (JUNCACEAE), A NEW RECORD FOR INDIA

During plant exploration in Dibang Valley, Arunachal Pradesh, we collected an interesting species of *Juncus*, which was kindly identified by Dr. F. Miyamoto of Tokyo University of Agriculture, Japan, to be *Juncus spumosus* Noltie. He also pointed out that the species constituted a new record for India.

A brief description and line drawing based on our own collections and relevant data are given to facilitate identification in the field.

Material Examined: Dibang Valley, Mayodia Pass, 2635 m, 20.viii.2000, M. Bhaumik & M.K. Pathak 2904 - CAL)

Juncus spumosus Noltie in Edinburg J. Bot. 51(2): 139. 1994.

Rhizomaceous herb, borne singly, sometimes with one or two offspring. Rhizome short, knobby. Stem 30-75 cm long, terete, arching over. Stem leaves 3-5, 7-18.5 cm long, 1.5-5 mm broad, channeled throughout or at least on upper part, 'V' shaped in cross section. Leaf sheaths gradually narrowed into blades. Ligules absent. Inflorescence terminal, 13-21 headed, 3-12 flowered with chestnut brown to deep glossy brown capitula.

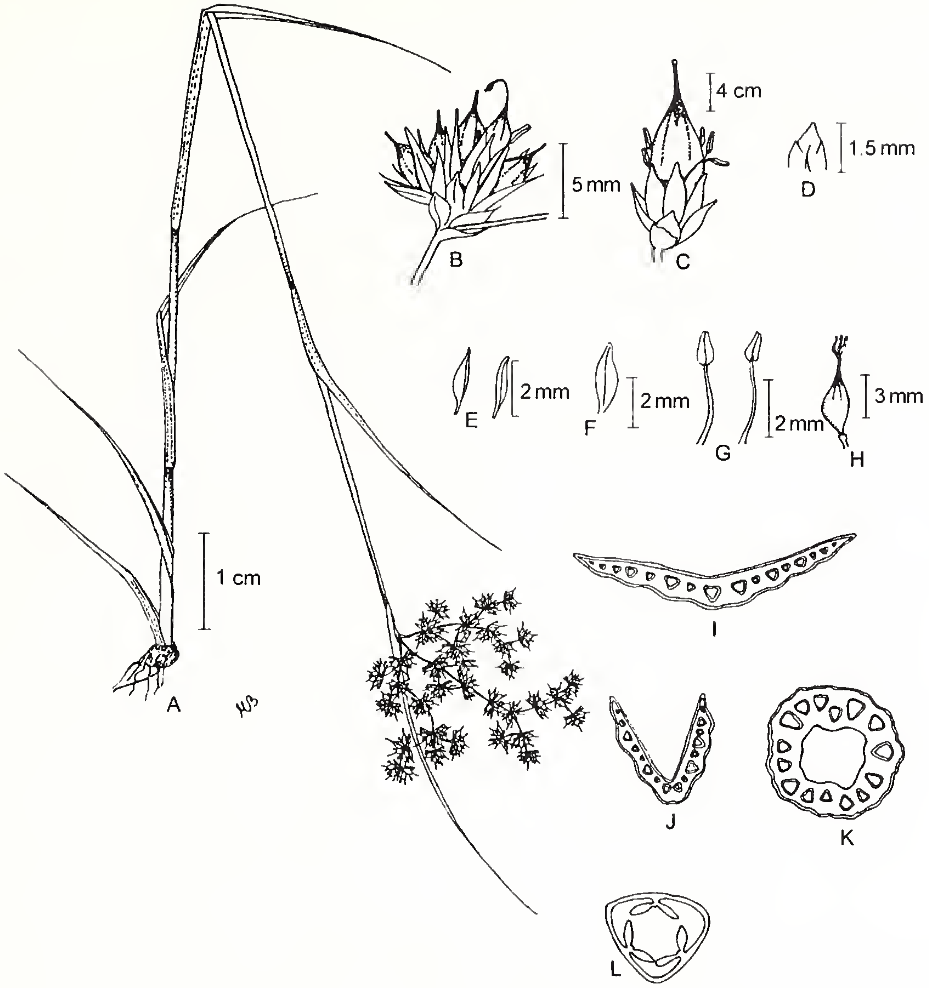

Fig. 1: *Juncus spumosus* Noltie, A. Habit, B. Part of inflorescence, C. Flower, D. Bract, E. Outer perianth, F. Inner perianth, G. Stamen, H. Capsule, I. Cross Section of leaf, basal part, J. Cross section of leaf, upper part, K. Cross section of stem, L. Cross section of capsule

Bract 1.5-2 x 1.5 mm, ovate, membranous. Flowers 8 x 3.5 mm, bracteate, shortly pedicellate, chaffy brown to deep brown. Outer tepals 3, 2.5 x 1 mm, boat shaped with prominent mid-vein, chaffy brown. Inner tepals 3, 3-3.5 x 1 mm, boat shaped with prominent mid-vein, acute, chaffy brown. Stamens 6, exerted, exceeding the tepals, straw coloured. Filament 3.5 mm long, filiform with broad bases. Anther lobe 1 x 0.5 mm, basifixed. Gynaecium 7 x 4.5 mm, ovate, deep glossy brown; style 2 mm, stigma triforked, mildly twisted with granular deposition. Seeds 2-tailed, 0.5-0.75 mm long.

Distribution: India-Arunachal Pradesh; Bhutan, China.

Notes: The plants were found bearing flowers and immature fruit at the time of collection. They were growing on moist, open, sandy hill slopes in association with *Chimonobambusa callosa* (Munro) Nakai, *Eriophorum comosum* (Wall.) Wall. ex Nees, *Gaultheria* spp., *Rubus calophyllus* C.B. Clarke and *R. lineatus* Reinw. The area experiences heavy rainfall and is snow bound during winter.

Though the species grows within the protected Dibang Dihang Biosphere Reserve, its habitat is threatened due to regular landslides and road reconstruction. Only a small population of about fifteen plants was found confined in the said locality.

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November 15, 2001

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40. FIVE NEW RECORDS OF PLANTS FROM TAMIL NADU

During a botanical exploration in Tirunelveli hills, Tamil Nadu, we came across five plant species, hitherto unreported from Tamil Nadu (Henry *et al.* 1987, Hooker 1872-1897). The nomenclature, brief diagnostic characters, phenology, collection site, field numbers and notes on the ecology and distribution of these taxa have been recorded.

Canthium pergracile Bourd. in J. Bombay nat. Hist. Soc. 12: 352, t.4., 1915. (Rubiaceae)

Trees. Leaves elliptic. Flowers green - pale yellow.

Fl. & Fr.: June-August.

Specimens examined: Manickam *et al.*, Papanasam hills, 12905, 15793, 16179 (XCH), Sundaresan *et al.*, Puliarai, 17024 (XCH).

Remarks: Rare in evergreen forests up to 1,000 m.

Distribution: Southern Western Ghats (India).

Hedyotis wynaadensis (Gamble) Rolla Rao & Hemadri in Ind. Forester 99: 372-380. 1973. (Rubiaceae)

Large shrubs. Leaves oblong - oblanceolate. Flowers white.

Fl. & Fr.: June-August.

Specimen examined: Manickam *et al.*, Papanasam hills, 17068 (XCH).

Remarks: Rare in moist deciduous forests at 350 m along stream banks.

Distribution: Western Ghats, India.

Jasminum roxburghianum Wall. ex Clarke, Fl. Brit. India 3: 595. 1887. (Oleaceae)

Climbing shrubs. Leaves ovate - elliptic or lanceolate. Flowers white.

Fl. & Fr.: July-September.

Specimen examined: Sundaresan *et al.*, Papanasam hills, 16882 (XCH).

Remarks: Rare in deciduous forests at 200 m.

Distribution: South India.

Litsea mysorensis Gamble in Kew Bull. 1925: 130. 1925 & Fl. Pres. Madras, 2: 865. 1957 [repr. ed]. (Lauraceae)

Trees. Leaves linear - lanceolate. Flowers white.

Fl. & Fr.: July-August.

Specimens examined: Manickam *et al.*, Upper Kothayar, 13578, 13585 (XCH).

Remarks: Rare in open evergreen forests at 1,450 m.

Distribution: Western Ghats (India).

Meyna laxiflora Robyns in Bull. Jard. Bot. Brux. 11: 228. 1928. (Rubiaceae)

Large shrubs. Leaves ovate - oblong. Flowers green.

Fl. & Fr.: April-June.

Specimen examined: Sundaresan *et al.*, Papanasam hills, 15751 (XCH)

Remarks: Found rarely in moist deciduous forests at 600 m.

Distribution: India and Java.

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June 18, 2002

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Editorial

Towards globalization of biodiversity

Charles S. Elton is considered the father of the biology of invasive species. His seminal book THE ECOLOGY OF INVASIONS BY ANIMALS AND PLANTS, first published in 1958, is still considered a classic and compulsory reading for anyone interested in this fast growing branch of ecology. Dispersal is a natural process, a part of evolution and ecology. In the case of plants, it generally takes place through seeds or spores, while in vertebrates it is mostly through the movement of adult animals. Few immigrants survive the hazards of the 'new world', competition from the native species and stochastic forces. Only a small percentage becomes naturalized, most die off due to natural causes. Some naturalized species do become invasive (Mack *et al.* 2000). It is these species we will discuss in this editorial.

All along our evolutionary history and travel, we human beings have helped in the spread of non-indigenous species into new territories. Perhaps some of the first species to travel to new territories with us were the goats, dogs and cereals. For millennia, we have served as both accidental and deliberate dispersal agents. This phenomenon is increasing exponentially with the increase in international travel and commerce. Non-indigenous species are appearing in new areas at a rate never seen in the history of this planet. This is resulting in the creation of homogenous ecosystems, with the same species of plants and animals everywhere. Distances are disappearing, barriers are breaking down and the world is becoming a global village – we are seeing the globalization of biodiversity. Or, to put it better, the globalization of monocultures. We find *Eucalyptus* spp. plantations everywhere, and most of the tropical wetlands are choked with Water Hyacinth *Eichhornia crassipes*.

In India, the environmental and socio-economic impacts of alien invasive species such as the Water Hyacinth, Lantana *Lantana camara*, Mesquite *Prosopis chilensis*, Water Lettuce *Pistia* sp., Scotch Broom *Cytisus scoparius*, and Congress Grass *Parthenium hysterophorus*, are evident to foresters and conservationists. Estimates of economic damage caused by invasives are not available for India. The cost of control of such invaders in USA exceeds $138 billion per year (Mack *et al.* 2000). Globally, almost 20% of the vertebrates thought to be in danger of extinction are threatened in some way by invasive species. The single biggest tragedy is the probably the loss of at least 200 of the 300 endemic cichlid species in Lake Victoria as a result of the introduction of the Nile Perch *Lates niloticus* to the lake (Lowe-McConnell 1993). In India, the impact of *Tilapia*, a fish brought from Africa, on the native fish fauna is not properly studied. This invasive species was deliberately introduced in the Western Ghats where some of the most endangered and endemic fish fauna are found. Since 1800, invasive species have entirely or partially caused the majority of bird extinctions (BirdLife International 2000). Virtually all these extinctions were of island birds lacking natural defences against introduced predators particularly rats, cats and mongooses. Introduced competitors, herbivores and plants impact on 72, 71 and 69 globally threatened species respectively. The highly restricted-range Narcondam Hornbill *Aceros narcondami*, found only on the 7.5 sq. km Narcondam Island, is negatively impacted through over-grazing by the semi-feral goats which are damaging forest regeneration. If these feral goats are not eliminated, it is estimated that in another 80 years there would not be enough old *Ficus* trees for these hornbills to nests (Ravi Sankaran, *pers. comm.* 2002). The negative impact of introduced Chital *Axis axis* on forest ecosystems on the islands of Andaman and Nicobar is well known and needs immediate action.

The impacts of various invasive species need urgent attention from the Government of India, as the problem is growing with the accelerated rate of species movements through trade, transport, travel and ballast water. The latter is considered to be the most important vector for trans-oceanic and inter-oceanic movements of invasive marine organisms. Good scientific knowledge and understanding of how alien species become harmful to ecosystems and to species is a prerequisite for adequate mitigation measures. This is a branch of ecology on which not much attention has been given by Indian scientists and conservationists. We do not even have a clear-cut policy on the introduction of non-indigenous species. Australia has recently adopted a national weed policy aimed at reducing the impact of plant invaders and South Africa is determined to clear all the invasive woody species from its river catchments in a 20 year programme (Mack *et al.* 2000). The National Wildlife Action Plan 2002-2016 (Ministry of Environment and Forests 2002) devotes one line to the problem of invasive species, while the draft National Environment Policy: 2004 of the Ministry of Environment and Forests is silent on this issue.

Article 8(h) of the Convention on Biological Diversity requires parties "as far as possible and as appropriate, [to] prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species".

Invasive species are also known to cause major economic losses in agriculture, forestry and several other segments of Indian economy and these losses should be systematically assessed through appropriate criteria and indicators. Some rough estimates, based on some simplistic and selective criteria, indicate economic and environmental losses to exceed US $ 115 billion per year (Pimentel *et al.* 2001). These estimates, however, require validation based on proper socio-economic surveys conducted for this purpose (Rana 2004).

We have many laws which are supposed to prevent the introduction, accidental or intentional, of non-native species. Some of the laws are as follows:

The Destructive Insects and Pests Act, 1914 (amendments in 2001)
The Plants, Fruits and Seeds Order, 1989 (amendments in 2001)
The Seeds Act, 1966 (and the Seeds Rules, 1968)
EXIM Policy 2002-2007
Indian Livestock Importation Act, 1898 (amendments in 2001)
The Fisheries Act, 1897 (along with State Fisheries Acts)
The Protection of Plants Varieties & Farmers Rights Act, 2001

However, these laws are either flawed or outdated, and generally not seriously implemented. The National Biodiversity Strategy and Action Plan (2004) recommends enactment of legislation to establish an autonomous Quarantine Authority of India, to control the entry of alien invasive species. Considering that the scope of dealing with invasive alien species is multi-dimensional and requires multi-disciplinary inputs, there is an urgent need for establishing the National Invasive Species Council.

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MOLLUSCAN FAUNA OF POINT CALIMERE WILDLIFE SANCTUARY
PART 1: GASTROPODA[1]

DEEPAK APTE[2]

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Studies were conducted in Point Calimere, located on the Coromandel coast in the Thanjavur district of Tamil Nadu. Point Calimere has diverse habitats, including sandy shores, mangroves and salt pans. Large numbers of molluscs are dragged out by fishing nets, and killed in thousands. *Volva sowerbyana, Tudicla spiralis, Strombus plicatus sibbaldi* and *Conus milne-edwardsi* were recorded for the first time from this area. *C. milne-edwardsi* was recorded after 80 years along the Indian coast, from which there is only one published record, in Mumbai in 1912.

Key words: Point Calimere, Gastropoda, Mollusca

INTRODUCTION

The Indian coastline is rich in molluscan diversity. Some literature is available on this diversity, notable among which are the works of Crichton (1941), Gravely (1941,1942), Subrahmanyam *et al.* (1952), Kundu (1965a, b), Subba Rao (1971, 1977, 1980), Rajgopal and Mukherjee (1978, 1982), Mookherjee (1985), Subba Rao *et al.* (1984, 1986, 1993) and Apte (1993). The only comprehensive work on the molluscan fauna of the southeastern coast of India is by Satyamurthi (1952, 1956). However, recent work on these molluscs was found to be inadequate. To update the status of molluscan diversity, several surveys were conducted on the southeast coast of India from 1990-1999. The present paper is part of this survey.

STUDY AREA

Point Calimere is located on the Coromandel coast in the Thanjavur district of Tamil Nadu (10° 18' N, 79° 51' E). It is bordered by the Bay of Bengal on the east and Palk Strait on the south. Point Calimere is represented by sandy shores, mangroves and salt pans. Mudflats are also seen near the old lighthouse. Tidal action is very high; thus shells with delicate sculpture are virtually absent, or the sculpture is eroded or absent.

Duration: The survey was conducted during December 18-28, 1998 and December 22-28, 1999. The present paper does not report the entire gastropod fauna of Point Calimere, but only the dominant species.

Threats: Large numbers of molluscs are dragged by fishing nets, and get killed in thousands. The important species dragged are *Turritella acutangula, T. attenuata, Phalium areola, Murex trapa, M. badius, Rapana bulbosa, Hemifusus pugilinus, Oliva oliva, O. gibbosa, Xancus rapa, Bursa spinosa, Tonna dolium, T. fasciata, Ficus variegata* and *F. fecoides*. Of these, *Xancus rapa* is sold in shops and the others are crushed to produce shell grit. Besides gastropods, several species of bivalves are also dragged out, the important ones being *Pecten tranquebaricus, Placenta placenta, Pinctada vulgaris, Pinna atropurpurea, P. bicolor* and *P. vexillum*.

New records: Some interesting records are marked with an asterisk (*). Two specimens of *Volva sowerbyana* were collected from sand bars close to the jetty. This is probably the first report of this species on the southeastern coast of India. Point Calimere is a new site for *Tudicla spiralis* (several individuals, both live and dead), *Strombus plicatus sibbaldi* (one specimen) and *Conus milne-edwardsi* (one specimen).

Family: Calyptraeidae

***Calyptraea extinctorium* Lamarck**

Description: Shell fragile, conical with pointed apex, shell surface smooth. Internal folded appendage conspicuous and attached to the internal wall of the shell. **Colour**: Whitish or dull brown marked with reddish lines. **Status**: Common.

***Crepidula walshi* Herrmannsen**

Description: Shell flat, elongate-ovate. Upper surface with concentric striae. **Colour**: White. **Status**: Common.

Family: Trochidae

***Umbonium vestiarium* (Linn.)**

Description: Small shell with smooth and highly glossy surface. Body whorl broad, angular. Spires depressed. Umbilicus filled with thick callus. Aperture ovate. **Colour**: Exhibits wide range of colour variation. Usually pale yellowish-brown with numerous white, red, brown trans-spiral lines. **Status**: Common.

***Trochus radiatus* Gmelin**

Description: Smaller than *T. stellatus*. More conical in shape. Surface sculptured by spiral rows of tubercles. Upper row of tubercles on each whorl larger than others. Columella smooth, without denticles. **Colour**: Yellowish-white ground colour with broad trans-spiral reddish/crimson bands, which usually get broken into irregular spots on basal portion of body whorl. **Status**: Common.

***Trochus stellatus* Gmelin**

Description: Shells large, heavy and top-shaped. Surface highly granulated. Lips serrated. Sides of the shells slightly arched, giving a somewhat rounded external appearance. Tubercles on the lowest spire of each whorl enlarged compared to *T. radiatus*. Columella denticulate. **Colour**: Dull green to brown with broad radial reddish bands. **Status**: Common.

Family: **Turbinidae**

***Liotia cidaris* (Reeve)**

Description: Very small in size with low spires. Entire surface strongly ribbed. Body whorl with strong nodules. Mouth ovate. Umbilicus partly filled with white callus. **Colour**: White with brown nodules. **Status:** Uncommon.

***Turbo intercostalis* Menke**

Description: Shell thick and large with stout spiral ridges on the surface. Trans-spiral grooves prominent on ridges, umbilicus open. **Colour**: Greenish-brown with irregular yellow patches. **Status**: Uncommon.

***Astraea semicostata* (Kiener)**

Description: Shell resembles *Trochus*. Base flat with fewer, but sharply elevated spires. Each whorl at the base bears a spiral row of spinous processes. Trans-spiral ribs on each whorl weakly developed. Finely and concentrically grooved base. Umbilicus filled by callus. **Colour**: Beached specimens usually white, fresh specimens dull brown to yellow brown. **Status**: Common.

***Phasianella nivosa* Reeve**

Description: Shells smooth, glossy, shape similar to that of *Littorina*. **Colour**: Brownish-red with coloured spiral lines. A prominent single row of dark brown spots on each whorl. **Status**: Rare.

Family: **Neritidae**

***Nerita albicilla* Linn.**

Description: Large shell compared to *Nerita oryzarum*. Spires flat, depressed below extremity of outer lip. Columellar region tuberculated. Body whorl finely ribbed. Outer lip abnormally thickened. **Colour**: Variable, but commonly whitish, irregularly blotched with greenish-black. **Status**: Common. Edible.

Family: **Architectonidae**

***Architectonica laevigata* (Lamarck)**

Description: Shell moderately large and more elevated than other species in this family. Surface finely grooved. Basal surface bears a raised outer marginal band, which is traversed by a single median spiral groove. **Colour**: Light purple/pink with a row of brown dots along the spiral ridges. **Status**: Common.

***Torinia dorsuosa* (Hinds)**

Description: Shell resembles *Umbonium*. Shell flat with convexly arched upper surface. Granular spiral ribs. Lowermost spiral rib on each whorl strongest. Umbilicus circular with toothed margin. **Colour**: Pale brown. **Status**: Common.

Family: **Cypraeidae**

Volva sowerbyana* Weinkauff

Description: Shell ventricose with both ends prolonged into canals. Lip margins thickened. Teeth absent. **Colour**: Flesh pink. Beached specimens bleached white. **Status**: Common.

Family: **Strombidae**

***Lambis lambis* (Linn.)**

Description: Shell very large and heavy with thick callus zone. Outer lip bears 7 finger-like channelled processes. Anterior canal long and pointed. Shell covered by horny periostracum. Shoulder angular and strongly nodulated near suture. **Colour**: Chestnut to cream yellow with brown markings. Callus and inner part smooth and white or cream in colour. **Status**: Common.

Strombus plicatus sibbaldi* Sowerby

Description: Among the smaller species. Spires very tall and slender on large body whorl. Each spire with two strong vertical ribs, with many fine riblets. Both lips strongly serrated on inner margin. **Colour**: White with brown mottling. Aperture white with light brown transverse striae. **Status**: Rare.

Family: **Tonnidae**

***Tonna fasciata* Bruguiere**

Description: Large shell. Body whorl ovately inflated with short conical spire. Sutures sunk in impressed grooves. Numerous broad and flattened spiral ribs present on entire surface. Columella slightly twisted. Umbilicus greatly reduced.

Colour: White with 4 broad, widely separated, brownish-yellow bands. **Status**: Common.

***Tonna dolium* Linn.**

Description: Moderately large Tun with thin and globular body whorl. Spires flat and conical. Surface bears strong spiral ribs. Fine riblets also present between main ribs. Columella obliquely striated. **Colour**: White ground colour with alternately arranged white spots on main ribs. **Status**: Abundant.

Family: Ficidae

***Ficus ficoides* (Lamarck)**

Description: Moderately large Tun with thin and fragile body whorl. Spires flat and conical. Surface spirally sculptured by strong ribs. **Colour**: Light brown with dark brown markings. **Status**: Common.

***Ficus variegata* Roding**

Description: Moderately large, fragile and delicate shell. Body whorl very large with slightly elevated spires. Shell surface finely serrated. **Colour**: Light brown with dark brown and reddish mottling. **Status**: Common.

Family: Cassidae

***Phalium areola* (Lamarck)**

Description: Moderately large shell. Spires sharply pointed. Well-developed varices present, one on each whorl. Body whorl with blunt, smooth, angular shoulder. Suture slightly impressed. Aperture moderately wide. Canal short and curved dorsally. Outer lip on inner margin strongly toothed. **Colour**: Creamy white with 4-5 spiral rows of large squarish dark brown or deep orange spots. **Status**: Common.

***Phalium glaucum* (Linn.)**

Description: Shell large, with strongly inflated body whorl. Spires short and conical. Body whorl smooth and glossy. Whorls with strong, angular shoulders beset with a row of sharply pointed tubercles. Outer lip thickened and highly denticulate on inner margin. **Colour**: Creamy white with light brown mottling. Interior of aperture dark brown. **Status**: Common.

***Phalium canaliculatum* (Bruguiere)**

Description: A small, fragile shell. Surface bears strong, regular spiral ridges. Suture sunk in deep, broad grooves. Columellar lip strongly plicate. Upper end of columellar lip with a few transverse ridges. Outer lip thickened and toothed within. **Colour**: White with yellowish-brown spots. **Status**: common.

Family: Bursidae

***Bursa granularis* Roding**

Description: Similar in appearance to *Bursa tuberculata*. Outer surface spirally tuberculated. Surface also with two pair of varices on each side. Posterior canal well-defined. Outer lip with strong teeth. Columella strongly folded. **Colour**: Dark reddish-brown with red brown tubercles. **Status**: Common.

***Bursa spinosa* (Lamarck)**

Description: Moderately large shell. Varices tuberculated. Body whorl bears fine, close set, spiral ribs which have a granular surface. Shell dorsoventrally compressed. Each whorl bears two varices, one on each side, forming a continuous ridge. These varices with strong, well-developed spines. Outer lip on inner margin strongly toothed, giving a frilled appearance. **Colour**: Pale brown, with some darker brown markings. **Status**: Common.

***Bursa margaritula* (Deshayes)**

Description: Shell small, broader in proportion to height. Varices strongly developed and traversed by granular surface. Columella with strong folds. Posterior canal deflected to right. **Colour**: Dark yellow brown with red brown tubercles. **Status**: Common.

Family: Cymatiidae

***Cymatium cingulatum* (Lamarck)**

Description: Shell moderately large with conical, elevated spire. Anterior canal strongly twisted. Surface with strong spiral ribs. Outer lip on inner side toothed. **Colour**: Pale yellow brown. **Status**: Common.

***Cymatium rhinoceros* (Lamarck)**

Description: Shell large, thick and heavy. Surface with thick and raised varices, of which two on body whorl are very prominent. Whorls angularly shouldered. **Colour**: Yellowish-brown with varices bearing orange patches. **Status**: Common.

Family: Naticidae

***Natica maculosa* Lamarck**

Description: Moderately larger than *N. picta* with slightly elevated spires. **Colour**: Pale brown with faint brown or yellow trans-spiral lines. Dots less compactly arranged. **Status**: Common.

***Natica traillii* Reeve**

Description: Shell small and globular. Umbilicus deep. **Colour**: Whitish with reddish-brown, irregular trans-spiral lines. **Status**: Common.

Natica lineata **Lamarck**

Description: Shell moderately large, globular, with inflated body whorl. Apex sharply pointed. Surface smooth and glossy. The most elegantly shaped shell among moon snails. Columella with callosity. **Colour**: Shell ashy white with close set, trans-spiral yellow or orange wavy lines. Upper few whorls pale blue or violet. **Status**: Common.

Natica didyma **(Roding)**

Description: Moderately large shell. Surface with fine trans-spiral striae. Body whorl very large with small or almost flat spires. Columellar border thickly callused and divided by transverse groove. **Colour**: Pale brown with callus and interior of the aperture both dark brown. **Status**: Common.

Natica rufa **(Born)**

Description: Shell large, thick and solid. Columella covered with thick callus. Aperture semicircular. **Colour**: Dull brown with one or two broad, brown spiral bands. **Status**: Common.

Polynices mamilla **(Linn.)**

Description: A moderately large shell. Surface smooth and glossy. Spires reduced, with large ovoid and elongated body whorl. Aperture obliquely inclined. Umbilicus completely filled by white callus. **Colour**: Pure white. **Status**: Common.

Eunaticina papilla **(Gmelin)**

Description: Shell small with inflated body whorl. Spires moderately elevated. Surface with fine spiral grooves. Aperture large, ovate and narrow posteriorly. **Colour**: white with brownish periostracum. **Status**: Common.

Sinum neritoideum **(Linn.)**

Description: Shell ovoid with inflated body whorl. Spires greatly reduced. Shell surface spirally and trans-spirally grooved. Aperture large, ovate. Umbilicus open. **Colour**: White to yellow brown. **Status**: Common.

Sinum cuvierianum **(Recluz)**

Description: Shell ovoid with inflated body whorl. Spires almost flat. Shell surface spirally and trans-spirally grooved. Aperture large, ovate. Shell about two and a half times as broad as tall. **Colour**: White to yellow brown. **Status**: Common.

Sinum delessertii **(Recluz)**

Description: Shell ovoid, flatter than the two previous species. Spires greatly reduced, less eccentric. Shell about three times as broad as tall. Shell surface spirally and trans-spirally grooved. Aperture large, ovate. Umbilicus open. **Colour**: White to yellow brown. **Status**: Common.

Family: Pyramidellidae

Pyramidella terebellum **(Muller)**

Description: Shell small, fragile and tall, conical. Shell surface spirally grooved, grooves fine and visible only under magnification. Aperture ovate. **Colour**: Each whorl of spire with three brown spiral lines. Two spiral lines very dark. **Status**: Uncommon.

Turbonilla crichtoni **Winckworth**

Description: Shell small, with tall spires. Shell surface ribbed, ribs broader than interstices. **Colour**: Light brown to pink. **Status**: Uncommon.

Odostomia babylonica **Winckworth**

Description: Shell small, fragile with moderately tall spires. Shell surface smooth. Aperture obovate. Sutures deeply incised. **Colour**: White. **Status**: Uncommon.

Family: Eulimidae

Eulima bivittata **(Hinds and A. Adams)**

Description: Shell very small, slender, with tall spires. Shell surface smooth. Aperture three times as high as broad. **Colour**: Shell light brown, with two dark brown bands on each whorl. Area between these bands pale brown. **Status**: Uncommon.

Family: Potamididae

Cerithidea fluviatilis **(Potiez and Michaud)**

Description: Shell moderately large with tall spires. Whorls strongly tuberculated. Each whorl with four spiral ridges, of which lowermost is reduced. **Colour**: Light to dark brown. **Status**: Abundant.

Family: Cerithiidae

Cerithium morus **Lamarck**

Description: Small ovate shell. Anterior canal deeply excavated. Body whorl with about 6-7 spiral rows of tubercles. Other whorls with three rows each. Outer lip finely ribbed on inner margin. Aperture D-shaped. A small fold present near posterior end. **Colour**: Dark greenish-grey with black tubercles. **Status**: Common.

Cerithium obeliscus **Bruguiere**

Description: Moderately large shell, slightly turreted in shape compared to other species. Surface sculptured with spiral rows of tubercles. Uppermost whorl strongest. Interstices between these spiral rows traversed by fine lattice of spiral and trans-spiral ribs. Anterior canal deeply excavated and produced in a curved spout. **Colour**: Pale brown with white markings. Irregular brown blotches also present. **Status**: Common.

***Cerithium splendens* Sowerby**

Description: Shells small with sharply produced anterior canal. Whorls with nodular spiral ridges. **Colour**: Pale brown with alternately arranged white and brown tubercles. **Status**: Common.

Family: Triphoridae

***Triphora concinna* Hinds**

Description: Shells very small and can be collected from shell sand. Shell elongated with small body whorl. Shell surface with three rows of spirally arranged tubercles. Body whorl with five rows of tubercles. **Colour**: Pale brown with dark brown band at base of each whorl. **Status**: Common.

***Triphora violacea* (Quoy and Gaimard)**

Description: Shells very small, can be collected from shell sand. Shell sinistral, shell sculpture almost same as that of *T. concinna*. **Colour**: Light violet with dark violet base. **Status**: Common.

Family: Janthinidae

***Janthina roseola* Reeve**

Description: Shell small, fragile, elongated. Basal surface flattened, with angular and small body whorl. Shell surface finely striated, with three rows of spirally arranged tubercles. Body whorl with five rows of tubercles. **Colour**: Pale brown with dark brown band at base of each whorl. **Status**: Common.

Family: Rissoidae

***Rissoina clathrata* A. Adams**

Description: Shell small, with many whorls. All except body whorl with three spiral ridges. Shell surface looks granular due to crossing of spiral and trans-spiral ridges. Outer lip thick, extended anteriorly. **Colour**: Pale brown. **Status**: Common.

Family: Mitridae

***Mitra circula* Kiener**

Description: Moderately large, thick shell, with tall spires. Surface spirally ridged. Two or three trans-spiral grooves and 13 to 15 strong spiral ridges on body whorl prominent. Upper whorls of spire with 3 spiral ridges each. Columella plated, 3-4 plates can be seen. **Colour**: Yellowish-brown. **Status**: Uncommon.

Family: Turritellidae

***Turritella acutangula* Linn.**

Description: Shell tall and thick. Whorls marked with spiral ridges, of which two are prominent. Callus polished, white. **Colour**: Yellowish-brown. **Status**: Common.

***Turritella attenuata* Reeve**

Description: Shell slender compared to *T. acutangula* and much taller. Spiral ridges prominent on each whorl, but more in number than in *T. acutangula*. Middle rib the strongest. **Colour**: Bluish-brown. **Status**: Common.

Family: Epitoniidae

***Epitonium scalaris* (Linn.)**

Description: Very small. Whorls are encircled by trans-spiral crests. Height of shell less than twice its breadth. Aperture D-shaped, its posterior edge touching one crest of the whorl above. **Colour**: White. **Status**: Uncommon.

***Eglisia tricarinata* Adam and Reeve**

Description: Very small and resembles juveniles of *Turritella duplicata*. Each whorl on lower half with three distinct spiral ridges. Spires tall and sharply elevated. **Colour**: Whitish with pale brown patches. **Status**: Common.

Family: Muricidae

***Murex badius* Reeve**

Description: Shell small, with spindle shaped body. Shell surface with seven varices. Spires well-developed. Anterior canal curved and short. **Colour**: Ashy brown, periostracum light brown. **Status**: Common.

***Murex trapa* Roding**

Description: Shell large, elongated. Anterior canal open, very long. Spires turreted. Outer lip with three strong spines. Whorls angularly shouldered. Surface spirally ridged with three strong varices. Each varix with strong spines. **Colour**: Fresh specimens dull brown to yellowish-brown. **Status**: Common.

***Murex haustellum* Linn.**

Description: Moderately large, thick but light shell. Varices prominent on each whorl. Entire surface with strong nodules. Inner margin of outer lip with strong folds. Long siphonal canal. Blunt spines on surface. **Colour**: Light pink ground colour with dark brown nodules. Inner margin of mouth light pink. **Status**: Uncommon.

***Murex virgineus* (Roding)**

Description: Shell large, thick, solid. Surface spirally ridged, with three varices ornamented by short processes. Anterior canal short, partially closed. **Colour**: Pale brown with pink aperture. **Status**: Common.

Murex adustus **Lamarck**

Description: Shell moderately large, thick, rough. Varices with thick set of foliaceous processes. Surface with strong, widely spaced spiral ridges. Abundant oyster growth seen on many individuals. **Colour**: Black with bluish-white aperture. **Status**: Common.

Chicorius ramosus **Linn.**

Description: Large, thick, heavy shell. Varices prominent on each whorl. Spires moderately large, elevated. Long anterior canal. Outer lip margin with well-developed, frilled spines. Largest Indo-Pacific Murex. **Colour**: White with pinkish aperture. **Status**: Common.

Rapana bulbosa **(Dillwyn)**

Description: Large, thick, heavy, globose shell. Spires low, grooved. Surface finely striated with weakly developed or blunt spines. Siphonal canal very short. **Colour**: Chestnut. **Status**: Common.

Drupa heptagonalis **(Reeve)**

Description: Shell small and robust, with broad trans-spiral ribs. Spiral ridges uniform. Outer lip with sharp, strong, elongated teeth. **Colour**: Pale brown with dark brown spiral bands. Columella and aperture light violet. **Status**: Common.

Drupa margariticola **(Broderip)**

Description: Shell small, spindle shaped. Surface with fine spiral ridges. Trans-spiral ribs prominent and single shouldered. **Colour**: Pale brown with dark brown spiral ridges. Aperture light purple. **Status**: Common.

Drupa tuberculata **(Blainville)**

Description: Shell small, broadly ovate. Prominent, uniformly and spirally arranged stout tubercles. Outer lip with strong nodules. **Colour**: Brown with dark brown tubercles. Teeth white. **Status**: Common.

Thais rudolphi **(Lamarck)**

Description: Smaller species than *T. bufo*. Thick, heavy, solid shell. Body whorl with a few strong, spirally arranged ribs. Numerous riblets also present between main ribs. Columella broad and enamelled. Outer lip finely serrated. **Colour**: Dark brown with alternate black and white spots arranged on spiral ribs. Columella brown. **Status**: Common.

Thais bufo **(Lamarck)**

Description: Large, thick, heavy and solid shell. Body whorl with blunt spines. Aperture large, canaliculated on both sides. Columella broad, smooth, extending beyond upper extremity of outer lip. **Colour**: Light brown. Outer lip margin alternately marked by white and brown spots. **Status**: Common.

Thais rugosa **(Born)**

Description: Large, thick, heavy and solid shell. Species resembles *Thais caranifera* in appearance. Body whorl with blunt spines; first process on body whorl well-developed compared to *Thais caranifera*. **Colour**: Light brown. Outer lip margin alternately marked by white and brown spots. **Status**: Common.

Thais tissoti **(Petit)**

Description: Small, thick, stout shell. Many tubercles present on entire surface due to crossing of spiral and trans-spiral ribs. **Colour**: White with brown nodules. **Status**: Common.

Thais intermedia **(Kiener)**

Description: Shells moderately large, solid. Surface rough with large, widely spaced processes in four rows, of which upper one is largest. Processes appear like pointed tubercles. Aperture wide, ovate. Outer lip with strong teeth. **Colour**: Whitish with dark brown tubercles. Aperture light blue, tinged with brown markings. **Status**: Common.

Jopas sertum **(Bruguiere)**

Description: Moderately large. Surface traversed by very fine spiral grooves. Shell spindle-shaped with short spires. Columella and outer lip with a single tooth at posterior end. **Colour**: Pale yellow brown with irregular dark brown and white markings. Aperture light yellow. **Status**: Uncommon.

Maculotriton serrialis **(Laborde)**

Description: Shell very small, spindle-shaped. Spires tall with 5-7 whorls. Surface with strong spiral and trans-spiral ridges. Crossing of these ridges gives strong nodular appearance to the surface. Outer lip prominent and having a strong tooth. **Colour**: Pale yellow to white with dark brown or orange bands. **Status**: Uncommon.

Family: Conidae

Conus amadis **Gmelin**

Description: Moderately large, thin and fragile shell. Surface smooth, glossy but sometimes spirally grooved. Spires sharply elevated at the last few whorls. Apex pointed. Body whorl sharply angular above. **Colour**: Dark brown/

orange with irregularly scattered whitish triangular spots. Two prominent spiral bands of densely packed brown to orange lines on body whorl. **Status**: Common.

Conus piperatus **Dillwyn**

Description: Small shell. Spires moderately tall, basal portion threaded. Body whorl distinctly angular above. Aperture narrow. Whorls of spire slightly raised into ridge-like thickening above suture. Trans-spiral plates as indicators of growth lines are prominent. **Colour**: Yellowish-brown with a prominent spiral white band across middle body whorl. Raised spiral striae marked with rows of brown spots. **Status**: Common.

Conus ebraeus **Linn.**

Description: Small, thick, stout shell. Spires moderately tall. Surface with raised spiral striae. Upper part of body whorl obtuse angled. **Colour**: White ground colour with four rows of black squarish spots on body whorl. A spiral row of prominent black squarish spots on rest of whorls. **Status**: Common.

Conus nussatella **Linn.**

Description: Large, thin, fragile, cylindrical, and tall conical shell. Spires short but acuminate. Body whorl with a rounded receding shoulder. Surface with fine spiral granular ridges. Operculum small, horny with apical nucleus. **Colour**: Creamy brown or yellow with white brown blotches. Fine reddish-brown dots and vertical dashes arranged in vertical and horizontal rows. **Status**: Common.

Conus araneosus **Hwass**

Description: Large, thick and heavy cone. Spires moderately elevated. Body whorl straight sided and broadly conical. Whorls concavely depressed. Body whorl sharply angular at upper end. Basal portion strongly threaded. Spires coronated, beset with raised tubercles. Trans-spiral plates prominent. **Colour**: White ground colour with brown mottling on entire surface. Fine brown irregularly scattered lines forming longitudinal bands. Body whorl with two prominent spiral bands of interrupted brown mottling. Aperture violet. **Status**: Common.

Conus milne-edwardsi **Jousseaume**

Description: Large, elegant and fragile shell. Shell is very tall with elevated spires. Fine spiral grooves can be seen on spires on close examination. A prominent deep cleft at the posterior end of the aperture. Aperture narrow and slightly broadened at the lower end. Lip thin with sharp, cutting edge. Body whorl bear very fine trans-spiral striations. **Colour**: One of the most brilliantly coloured cones. Base colour creamish brown with white triangular spots. The tip of these spots is directed away from aperture. Spire bears dark brown wavy markings. Two prominent spiral bands on body whorl are diagnostic. **Status**: Endangered.

Family: **Terebridae**

Duplicaria duplicata **(Linn.)**

Description: Shell small, tall and slender. Surface with numerous trans-spiral ribs separated by spiral grooves and fine spiral ridges. Trans-spiral ribs prominent, single-shouldered. **Colour**: Pale brown with dark brown markings. Pale yellow spiral band clearly visible above each suture. **Status**: Common.

Family: **Turridae**

Surcula javana **(Linn.)**

Description: Moderately large shell with tall, conical spires. Shoulders angular. A nodulated spiral ridge prominent at centre of each whorl. Entire surface sculptured with spiral and trans-spiral ribs that are prominent on body whorl. Crossing of these ribs gives a nodular appearance to the surface. **Colour**: Deep brown. **Status**: Common.

Surcula amicta **Smith**

Description: Small shell with raised spires and pointed apex. Surface smooth, glossy. Turrid notch weakly developed. Canal short, wide. **Colour**: Creamy white with brown wavy markings. **Status**: Common.

Family: **Buccinidae**

Babylonia spirata **(Linn.)**

Description: Moderately large, thick and heavy shell. Body whorl large, with a few deeply grooved spires. Whorls inflated. Surface sunk in broad grooves. Columella smooth, well-developed. Umbilicus filled with callus. Aperture large, constricted posteriorly by a thick ridge extending inwards on columellar side. Anterior canal represented by a notch. **Colour**: White ground with regular spiral row of large squarish orange spots. Fresh specimens always covered with brown periostracum. **Status**: Common. Edible.

Cantharus undosus **(Linn.)**

Description: Small, spindle-shaped shell. Surface traversed by well-developed, strong, close set spiral ribs. Outer lip margin thickened and strongly denticulate. Fasciole absent. Thick brown periostracum covering the shell. Anterior canal open, inclined. Columellar border concavely excavated. **Colour**: White with reddish-brown spiral ribs. **Status**: Common.

Family: **Fasciolariidae**

***Fasciolaria trapezium* (Linn.)**

Description: Shell very large and heavy. Whorls strongly shouldered. Shoulders with strong tubercles. Columella with a few folds. Aperture spirally striated. **Colour**: Pale yellow brown, marked with dark brown paired lines. **Status**: Uncommon.

***Fusinus longicauda* (Bory)**

Description: Large, spindle-shaped shell with tall spires. Shell resembles *F. colus*, a species from Sri Lanka. Siphonal canal very long and open. Spiral ridges well-developed on entire surface, of which the middle one on each whorl is stronger and raised. These ribs become increasingly oblique towards canal. Last few whorls with well-developed trans-spiral ribs. Sutures sunk. Shoulders with weakly developed nodules. **Colour**: Pure white. **Status**: Common.

***Fusinus toreuma* (Lamarck)**

Description: Shell large, thick, solid and spindle-shaped. Surface with thick spiral ridges. Angular shoulders on each whorl bearing large tubercles. Anterior canal stout and long. **Colour**: Whitish with dark brown markings. Aperture white. **Status**: Common.

Family: **Volutidae**

***Harpulina lapponica* Linn.**

Description: Large, thick ovoid shell. Spires short, conical. Body whorl elongated, inflated. Columella having 6-7 strong folds. Spires weakly grooved. Surface smooth. Last few whorls with prominent trans-spiral ribs. **Colour**: Cream white or pale yellowish ground colour with dark brown, indistinct mottling on surface. **Status**: Uncommon.

***Cymbium melo* (Solander)**

Description: Shell very large, thin, fragile with enlarged, inflated body whorl. Spires completely reduced in adults. Surface with trans-spiral grooves. Aperture very wide. **Colour**: Bright yellowish-orange with dark brown patches on body whorl. **Status**: Uncommon.

Family: **Olividae**

***Oliva gibbosa* (Born)**

Description: Stout, thick, glossy shell. Body whorl elongate-ovoid, inflated, with two strong spiral cords at the base. Callus well-developed with close-set ridges. Spire short with pointed apex and depressed lower part. **Colour**: Light yellowish-brown with deep olive green mottling. **Status**: Common.

***Oliva nebulosa* Lamarck**

Description: Small shell with glossy surface. More slender and elongated than *O. gibbosa*, with less inflated body whorl. Columellar margin with folds which are more numerous than in *O. gibbosa*. **Colour**: Pale bluish-grey or whitish, mottled with greenish-blue markings. Pale brown oblique spiral bands with thick, darker brown markings at the base of body whorl. **Status**: Common.

***Ancilla ampla* (Gmelin)**

Description: Small, smooth with glossy surface. Spire small, with large body whorl. Aperture large but narrow. **Colour**: Whitish, tinted with bright orange brown. **Status**: Uncommon.

***Ancilla cinnamomea* (Lamarck)**

Description: Shell stouter and shorter than *A. ampla*. Body whorl strongly inflated with two oblique spiral grooves at base. **Colour**: Polished dark brown or coffee brown. **Status**: Uncommon.

***Ancilla acuminata* (Sowerby)**

Description: Similar to *A. cinnamomea* but has raised spire and more pointed apex. Base of body whorl narrower than *A. cinnamomea*. **Colour**: Pale brown with darker shade below two oblique spiral grooves on body whorl. **Status**: Rare.

***Ancilla scaphella* (Sowerby)**

Description: A smaller species than *Ancilla acuminata*. Spire small with blunt apex. Body whorl relatively enlarged, equally wide at both ends. Aperture very wide. **Colour**: Whitish with brown suture. **Status**: Uncommon.

Family: **Nassariidae**

***Bullia melanoides* (Deshayes)**

Description: Shell small, with glossy surface and tall spires. Shell surface with trans-spiral ridges and fine spiral grooves. 4-5 spiral grooves present at base of body whorl. **Colour**: Dark grey with purple tinge. **Status**: Common.

***Nassarius jacksoniana* (Quoy and Gaimard)**

Description: Shell small with strong raised trans-spiral ridges. Outer lip thickened at edge, with tooth inside. Base of body whorl with 2-4 impressed lines. **Colour**: Olive green with white trans-spiral ribs. **Status**: Abundant.

***Nassarius hepatica* (Montagu)**

Description: Larger than *N. jacksoniana*. Spires well-elevated. Strong trans-spiral ribs present on entire surface. A single spiral groove cuts trans-spiral ridges below suture, forming nodular sculpture. **Colour**: Olive green to light brown. Aperture marked with two white bands on black background. **Status**: Uncommon.

Nassarius costata **Adams**

Description: Similar to *N. hepatica*. Spires comparatively well-elevated. Trans-spiral ribs finer, close-set. **Colour**: Pale grey with dark brown spiral bands. Aperture marked with brown bands on white background. **Status**: Common.

Nassarius thersites **(Bruguiere)**

Description: Shell small with short spires. Body whorl large, inflated. Callus flat on columella, extends and conceals entire body whorl. Part adjoining columellar border traversed by trans-spiral ribs. Margin of outer lip reflected, thickened and toothed within. **Colour**: Ashy green with a dark central spot on body whorl. Callus white. **Status**: Common.

Nassarius suturalis **(Lamarck)**

Description: Comparatively larger than *N. thersites*. Surface sculptured by fine, orange spiral lines. Columella with a strong tooth. Outer lip on inner side with strong tooth. **Colour**: Whitish with orange spiral lines. **Status**: Uncommon.

Nassarius pallidula **Adams**

Description: A smaller species with elevated, pointed spire. Surface traversed by fine spiral grooves. Callus present on columella, which also bears a single strong tooth. Outer lip thickened. **Colour**: Yellowish-brown. **Status**: Uncommon.

Family: Vasidae (= Turbinellidae)

Xancus rapa **(Lamarck)**

Description: Shell large, solid, heavy, pear-shaped. Always covered with brown periostracum. Spire well-elevated. Shoulder ridge with strong, blunt tubercles. Columella with four strong folds. **Colour**: Ivory white. Young specimens with dark brown spots. **Status**: Abundant.

Tudicla spirillus **(Linn.)***

Description: Moderately large in size. Apex thick, rounded with depressed spires. Spires with blunt tubercles. Body whorl broad, inflated, angled with a long, curved siphonal canal. Callus well-developed. Protoconch clearly visible. **Colour**: Light yellowish-brown with white and brown spots. Tubercles are dark brown. **Status**: Rare. This species is endemic to southeast India.

Family: Volemidae

Hemifusus pugilinus **(Born)**

Description: Massive shell with well-elevated spires. Basal portion with coarse, close set spiral ridges. Whorls having angular shoulder with strong tubercles. Operculum thick, ovate, horny, anterior canal with broad opening. **Colour**: Pale brown covered with thick periostracum. **Status**: Common.

Hemifusus cochlidium **(Linn.)**

Description: Whorls strongly and angularly shouldered. Shoulder with strong tubercles, which are fewer and more widely separated than in *H. pugilinus*. Spiral ridges prominent, except on body whorl. Sutures sunk in deep, narrow grooves. Aperture elongated and rectangular. Anterior canal wider than in *H. pugilinus* near base. **Colour**: Dark reddish-brown. Columella pale yellow brown. Periostracum brown. **Status**: Common.

Family: Harpidae

Harpa conoidalis **Lamarck**

Description: Large, thick but fragile shell. Surface with strong, widely spaced trans-spiral ribs. Interspaces between ribs traversed by fine trans-spiral striae. Columella smooth and polished. **Colour**: Pale fleshy brown, marked with transverse brown lines. Columella with chestnut coloured blotches. Interior of aperture smoky brown. **Status**: Common.

Family: Pilidae

Pila dolioides **(Reeve)**

Description: Moderately large, fragile shell with large body whorl. Spires more or less flat. Body whorl globular. **Colour**: Light purple. **Status**: Common.

Family: Marginellidae

Marginella angustata **Sowerby**

Description: Shell small, smooth, ovoid. Spires completely enveloped within body whorl. Outer lip thickened and smooth within. Columella with 4 strong folds. **Colour**: Bluish white ground colour with greenish-brown spiral bands. Fine white prominent trans-spiral lines. **Status**: Common.

Family: Bullidae

Bulla ampulla **Linn.**

Description: Moderately large, thick, globose, fragile shell. Expanded body whorl. Lip extended posteriorly beyond apex, slightly constricted centrally and expanded anteriorly. Columella reverse S-shaped, smooth with thin callus. **Colour**: Cream with dark purple brown blotches, clouded with dark brown. **Status**: Common.

Family: **Hydatinidae**

***Hydatina velum* (Gmelin)**

Description: Moderately large, thin, fragile and elegant shell. Spires flat. Suture deeply sunk in groove. Aperture wide. Surface with fine growth lines. Lip thin. Columella with thin callus. **Colour**: Waxy white. Four broad spiral bands of brown. Central band edged on each side with unbroken, dark brown lines. **Status**: Uncommon.

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REVISION OF SOME SPECIES OF FAMILY SCHIZOMIDAE (ARACHNIDA: SCHIZOMIDA) ON THE BASIS OF TYPES DEPOSITED BY F.H. GRAVELY (1911-1925) IN THE NATIONAL COLLECTION, ZSI, KOLKATA[1]

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The redescription of six species, namely *Schizomus sijuensis*, *S. lunatus*, *S. perplexus*, *S. greeni*, *S. vittatus* and *S. cavernicola* of schizomid arachnids described by F.H. Gravely (1911-1925), have been provided, with illustrations to facilitate their identification. *S. sijuensis*, *S. perplexus* and *S. cavernicola* have been redesignated as new combinations. The specimens studied were deposited in the National Collection of the Zoological Survey of India, Kolkata by F.H. Gravely, and are the lectotypes. These species are redesignated on the basis of revisionary studies by Harvey, Reddell and Cokendolpher.

Key words: Redescription, *Schizomus*, *sijuensis*, *lunatus*, *perplexus*, *greeni*, *vittatus*, *cavernicola*, *tikaderi*, *chaibassicus*, *chalakudicus*, India, Sri Lanka, Myanmar

INTRODUCTION

Schizomids are minute arachnids rarely encountered in the field. They are nocturnal, most secretive and prefer selective habitats. Southeast Asian schizomid fauna was initially explored by Pickard-Cambridge (1872), Thorell (1883-1889) and Pocock (1900), who mainly concentrated on small countries like Burma (now Myanmar), Ceylon (now Sri Lanka), Malaysia and Sumatra.

Pickard-Cambridge raised the Family Tarteridae to a Suborder Tarterides and described *Nyctalops crassicaudatus* P. Cambridge [= *Schizomus crassicaudatus* (P. Cambridge)]; locality Royal Botanical Gardens, Peradeniya, Kandy District, Sri Lanka. Subsequently, Thorell described *Trithyreus grassi* (Teinzo, Burma) (Reddell and Cokendolpher 1985) and *Trithyreus cambridgei* (Prone, Burma). Under the same Suborder, Pocock (1900) in his monumental work FAUNA OF BRITISH INDIA: ARACHNIDA described a new species *Trithyreus suboculatus* (Ceylon). He also included three species described by Pickard-Cambridge (1872) and Thorell (1883-1889). Gravely (1911-25) contributed first on Burmese and Ceylonese Schizomids by describing *Schizomus cavernicola* (Khayon Caves, Burma), *S.* (*Tr.*) *paradeniyensis*, *S.* (*Tr.*) *vittatus*, and *S.* (*Tr.*) *greeni* (Pundalu-oya, Marurata and Ambalagoda, Ceylon respectively, and three species from India as *Schizomus* (*Tr.*) *sijuensis* (Siju caves, Garo Hills, Meghalaya), *S.* (*Tr.*) *kharagpurensis*, and *S.* (*Tr.*) *lunatus* (Kharagpur and Botanical Garden, Calcutta, West Bengal). Further, in 1915, he described *S.* (*Tr.*) *perplexus* and *S.* (*Tr.*) *buxtoni* (Polonuruwa, Ceylon), he also reported *S.* (*Tr.*) *modestus* Hanson (Tiga and Terneh caves, Malaya). Fernando (1957) described *Schizomus formicoides* (Colombo, Ceylon).

Bastawade (1985) and Bastawade and Pal (1992) have reported the order Schizomida for the first time from Indian states Maharashtra and Arunachal Pradesh respectively. Sissom (1980), Cokendolpher and Reddell (1986), Cokendolpher (1988), and Cokendolpher and Sites (1988) have studied eastern Asian schizomids and have described some new species. Cokendolpher *et al.* (1988) have described *Schizomus tikaderi*, the first species from a peninsular Indian state Maharashtra. Further, *Schizomus crassicaudatus* (Pickard-Cambridge) has been redescribed and diagnosed by Reddell and Cokendolpher (1991) on the basis of lectotypes and paralectotypes from University of Oxford, U.K. and Zoologisk Museum, Copenhagen. Reddell and Cokendolpher (1995) have compiled literary and revisionary studies of about 180 schizomid species from all over the world. The genus "*Schizomus*" has been split into many new genera mainly on the basis of studies of spermathecae and other subletting characters, the known species *Schizomus tikaderi* Cokendolpher *et al.* (1988) has been transferred to *Neozomus tikaderi* comb. nov. Reddell and Cokendolpher (1995), in their monograph, have provided complete synonymies, published and unpublished records, habitat information, and bibliography for every taxon of the Order Schizomida. Bastawade (2001) redescribed *Schizomus buxtoni* (Gravely), unaware of the revision by Reddell and Cokendolpher (1995). The taxonomic status of *S. buxtoni* (Gravely) changed to *Apozomus buxtoni* (Gravely) comb. nov.

Gravely deposited most of his type specimens in the collection of the erstwhile Indian Museum, Calcutta (= Kolkata), now the National Collection in the custody of the Zoological Survey of India, Kolkata. The type material representing Indian, Ceylonese and Burmese species of Schizomida were studied and are being reported here. Two new species *Schizomus chaibassicus* (Chaibass Pass, Chhota Nagpur, Madhya Pradesh, India) and *S. chalakudicus* (Chalakudi, Trichur (= Cochin), Kerala, India) have been identified and described by Bastawade (2002). Accordingly, this communication deals with the description of 6 species under the respective proposed genera by Reddell and Cokendolpher (1995) "*Schizomus*" *greeni* Gravely and "*S*". *vittatus* Gravely could not be studied due to lack of information.

1. ***Trithyreus sijuensis*** **(Gravely) comb. nov.** (Figs 1-13)

1925. "*Schizomus*" (*Trithyreus*) *sijuensis* Gravely, *Rec. Indian Mus. 26*: 61-62.

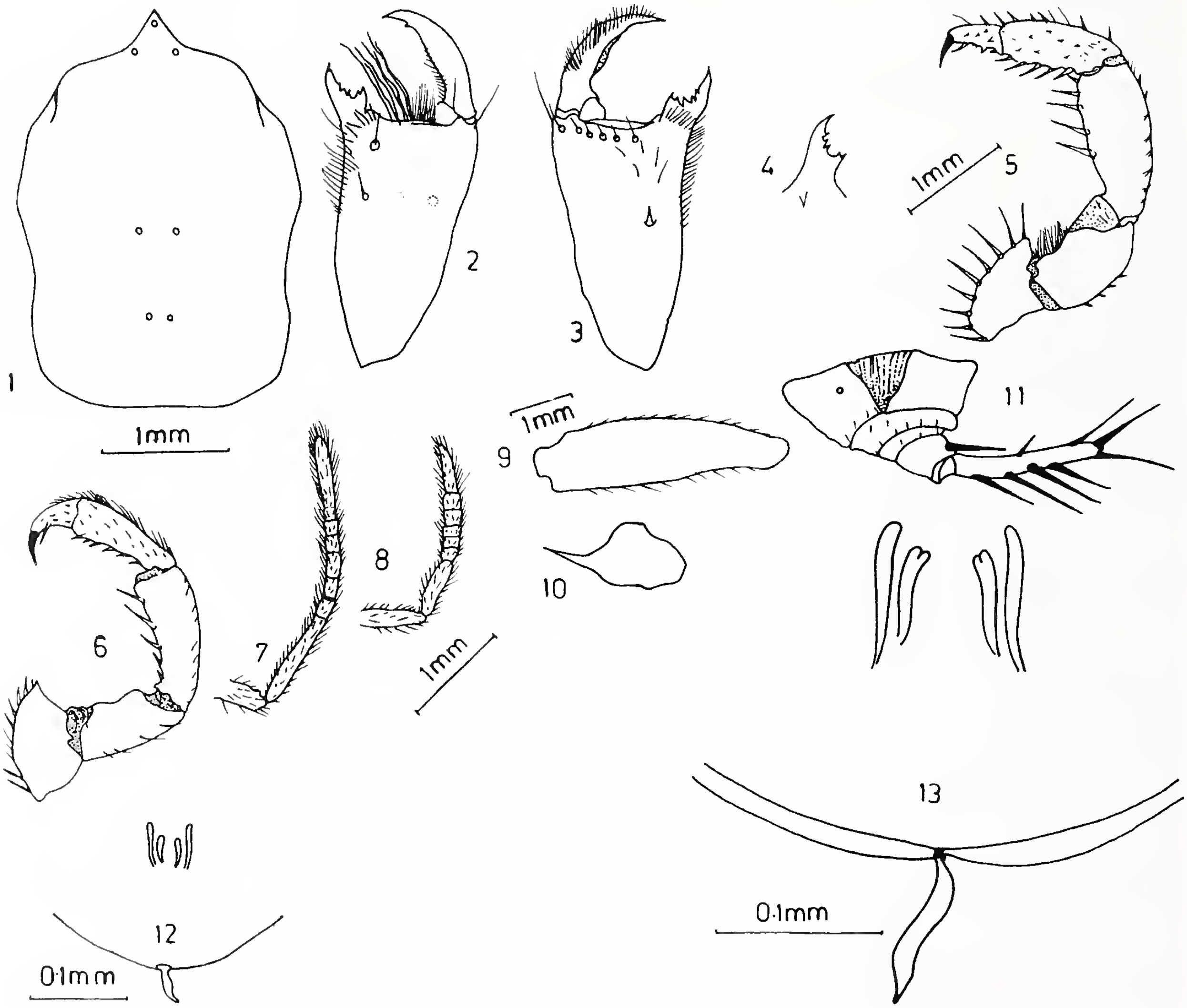
1995. *Schizomus sijuensis* Reddell and Cokendolpher, *Texas Mem. Mus. Speleol. Monogr. No. 4*: 4,11,20 and 54.

2002. *Schizomus sijuensis*: Bastawade, *J. Bombay Nat. Hist. Soc. 99(1)*: 90-95.

General: Female with yellowish-brown body, distal portions of pedipalps and chelicerae more brownish, distal portions of legs paler. Body surface smooth. Pedipalp stout, strong and expanded on trochanter. Flagellum single segmented.

Measurements (in mm): Total length 7.80; Cephalothorax 3.03, abdomen 4.77 (Tables 1, 2).

Cephalothorax: Propeltidium almost twice as long as wide, anterior margin narrowing into pointed anterior process,



Figs 1-13: *Trithyreus sijuensis* (Gravely) comb. nov., 1. Carapace (Propeltidium), dorsal view, 2. Chelicera, outer view, 3. Chelicera, inner view, 4. Immovable (fixed) finger of chelicera, lateral view, 5. Pedipalp(♀), lateral (mesal) view, 6. Pedipalp (♂), lateral (mesal) view, 7. Tarso-basitarsus (♀), lateral view, 8. Tarso-basitarsus (♂), lateral view, 9. Femur IV (♂), lateral view, 10. Coxa II, lateral view, 11. Flagellum (♀) with abdominal segments XI-XII, lateral view, 12. Spermathecae, ventral view, 13. Spermathecae, ventral view, enlarged

smooth, bearing one median seta and one pair of setae at the base of the process. Three pairs of dorsal setae present; Eye spots absent (Fig. 1). Mesopeltidium almost touching each other medially, Metapeltidium undivided but with a median suture. Anterior sternum with 9 setae and 2 sternapophysial setae, posterior sternum not sclerotized and setation not clear.

Abdomen: All tergites and sternites smooth, setal composition not clear as all setae have dropped off from specimen. Tergites III-VIII each with a pair of round impressions for dorso-ventral muscles. Flagellum 1 mm long and 7-8 times longer than wide, of single annulus, setose and *2d*, *2dl*, *4v* and *2vl* setae (Fig. 10). Genital sternum wider than long, spermathecae double, elongated tubular lobes and tubular walls not very thick on each side (Figs 11-12).

Appendages: *Chelicera*: Basal segment with posterior dorsal depression, fixed finger with only three teeth between proximal and distal large teeth Fig. 4), movable finger with smooth, obsolete serrula with only a minute distal tooth (Figs 2, 3). Types of setae present 1-4, 2-7, 3- (unclear, except one), 4-2, 5-8 and 6-1. *Pedipalp*: Short, strong and stout, expanded on trochanter and pointed distally, laterally compressed, only three pilose weak and long setae on ventrolatero-distal margin, many pilose setae of various sizes present on ventrolateral margin; femur shorter and stouter, bearing series of small, short, stout setae on interior side, whereas outer portion bears only three to four longer, spinulose setae, otherwise smooth; patella longer than femur, smooth, with a few scattered spinulose setae on outer surface, inner surface with double row of strong setae, a row of 4 spinulose setae on dorsal and three spinulose setae on ventral side; tibia almost as long as patella, smooth, with pilose setae, inner margin with upper and lower rows of spinulose setae of various lengths except 2-3 stouter spines; tarso-basitarsus with mesal spine smaller and closer than lateral spine, ventral and mesoventral surface with many long, pilose setae; claw almost equal to tarso-basitarsus length (Figs 5, 7). *Legs*: all legs damaged, coxae II bearing a long, stout, anteriorly pointed spine (Fig. 13); Femur IV almost 3.84 times longer than wide, setation not clear (Fig. 9).

Lectotype: ♂ Total length 7.80 mm, Cephalothorax 3.30, abdomen 4.50; flagellum damaged, anterior process of propeltidium with a median seta and a pair of basal setae; anterior sternum with 4 visible setae, with 2 sternapophysial setae, posterior sternum with 4 setae, sternite VI with 13-14 setae on anterior portion, 2 setae on posterior portion, sternites VII-IX each with a row of posterior marginal setae; flagellum broken and missing; chelicera with 6-7 more setae at the base of movable finger; tarso-basitarsus proportion as 20:7:9:8:5:9:31. Femur IV 3.43 times longer than wide. Leg formula 1423.

Type data: **Holotype**: 1♀, 1♂ (lost), 2♀♀ immature, 1♀ (broken), from Garo Hills, Meghalaya (previously Assam), 3,500-3,610 ft elevation at the entrance of Siju caves, Coll. F.H. Gravely, dt. not recorded. **Lectotype**: 1♂, (flagellum broken and lost) from Garo Hills, Meghalaya (previously Assam), 2,500 ft elevation, Coll. F.H. Gravely, Feb. 1922, deposited in National Zoological Collection, ZSI, Kolkata, Regn. No. 5349/H2.

Table 1: Measurements (in mm) for ♀ *Trithyreus sijuensis* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	0.96	0.69	0.30	0.39	0.42
Femur	1.02	2.67	1.44	1.41	2.19
Patella	1.17	3.54	0.99	1.02	1.05
Tibia	0.84	2.73	1.26	-	1.44
Basitarsus	0.81	1.41	0.54	-	-
Tarsus			0.87	-	1.05
Total	4.80	11.04	5.40	-	-

Table 2: Measurements (in mm) for ♂ *Trithyreus sijuensis* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	1.38	1.63	0.60	0.78	0.95
Femur	1.50	2.63	2.40	1.80	2.95
Patella	1.68	4.50	1.15	0.88	1.53
Tibia	1.50	2.68	1.65	1.20	2.50
Basitarsus	0.63	2.23	1.05	1.00	1.05
Tarsus			1.15	1.33	1.55
Total	6.69	13.67	8.00	6.99	10.53

Remarks: After studying the descriptions, character tables and illustrations given by Reddell and Cokendolpher (1995), the author proposes to transfer the species *Schizomus sijuensis* Gravely to *Trithyreus sijuensis* (Gravely) comb. nov.

2. "***Schizomus lunatus***" **Gravely** (Figs 14-24)

1911a. *Schizomus (Trithyreus) lunatus* Gravely, *Rec. Indian Mus. 6*: 33-38.

1985. *Schizomus lunatus* Bastawade, *J. Bombay Nat. Hist. Soc. 82(3)*: 690.

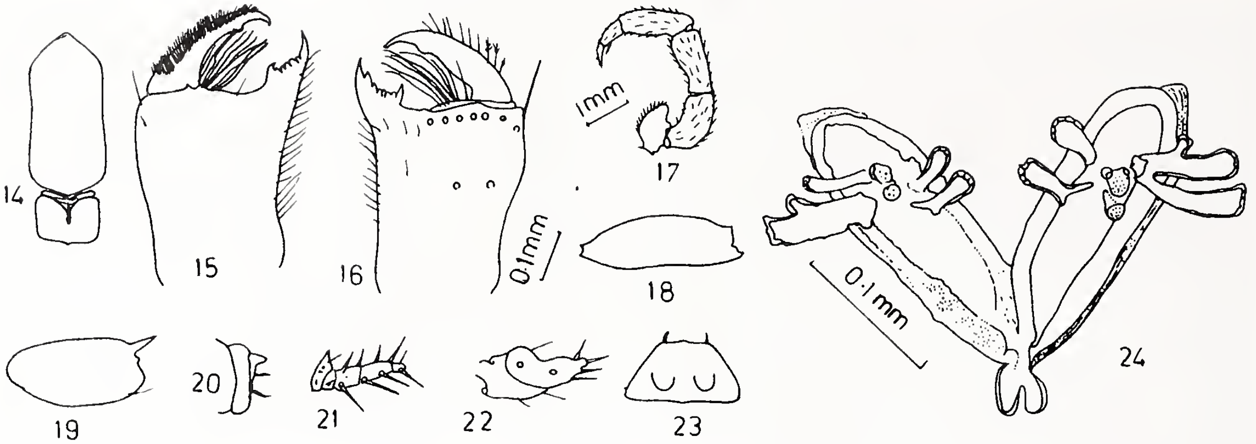
1987. *Schizomus lunatus* Cokendolpher, *Insecta mundi 2(2)*: 90-96.

1995. "*Schizomus*" *lunatus* Reddell and Cokendolpher, *Texas Mem. Mus. Speleol. Monogr. No. 4*: 4, 11, 20 and 54.

General: ♂ Body yellowish-orange, chelicerae and pedipalp browner, distal portions of legs lighter in colour.

Measurements (in mm): ♂ **Lectotype**: Total length 5.51; Cephalothorax length 2.17; Abdomen length 3.34 (Tables 3 & 4).

Cephalothorax: Propeltidium anterior margin medially produced into a process, not very sharply bent down, provided with anterior median seta followed by a pair of setae, dorsal setation not clear except one pair at 0.86 and second pair at 1.57 mm from anterior margin. Eyespots absent. Mesopeltidium small and the central gap between plates about 0.5 times, metapeltidium medially separated by a narrow median suture



Figs 14-24: *Schizomus lunatus* Gravely, 14. Pro, meso and metapeltidium, dorsal view, 15. Chelicera, outer view, 16. Chelicera, inner view, 17. Pedipalp, lateral (mesal) view, 18. Femur IV, lateral view, 19. Coxa II, lateral view, 20. Distal end of abdominal segment XII, lateral view, 21. Flagellum (♀), lateral view, 22. Flagellum (♂), lateral view, 23. Sternite I, ventral view, 24. Spermathecae, dorsal view (Cokendolpher, pers. comm.)

up to 2/3rd anterior portion, only one pair of posterior setae present (Fig. 14). Anterior sternum with 8 visible setae and a pair of long sternapophysial setae, posterior sternum unsclerotised and without setae.

Abdomen: Tergites I-VII with a pair of dorsal setae each, tergite VIII with one pair of dorsal and one pair of dorso-lateral setae, tergite IX almost half the length of preceding segment, with one dorsal pair and one dorso-lateral pair of setae. Sternites V-VIII with an anterior irregular row of setae each, amongst only 3 plumose setae on V, 5 on VI and 1 on VII visible, middle row clear only on VII with 1 seta, and VIII with 3 setae, posterior row on posterior margins with 5 stout setae on V, 2 on VI and 1 each on VII and VIII, setation not clear on sternite IX. Segments X-XII telescoped, with a distinct short, stumpy, posterior process on posterior dorsal margin of segment XII (Fig. 19). *Flagellum*: short, single segmented and about 0.35 mm long, with a short stalk and almost spade-shaped with *5d*, *4l* and *6v* pairs of setae (Fig. 22).

Appendages: *Chelicera*: basal segment smooth with setae Type 1-3, 2-3, 3-6, 4-2, 5-3 and 6-1, fixed finger with 3 teeth between two large outer teeth, movable finger with only one minute tooth on inner lateral margin, serrula almost smooth and obsolete, without teeth (Figs 15, 16). *Pedipalp*: Trochanter produced and pointed distally, with seven stout setae (Fig. 17); femur broad, short, armed with 6-7 stout setae on outer surface, and 2-3 pairs of setae present on inner surface (Fig. 17); patella not as broad as femur but elongated, more smooth and inner surface armed with 2 stout and 1 weak pilose setae; tibia shorter and thinner than patella, armed with 3-4 setae on inner surface, 3 setae on outer surface; tarso-basitarsus slightly more than half the tibial length, narrowed distally and armed with 3-4 pilose setae on inner surface, mesal spur equal to half the claw, claw curved, sharp and slightly shorter than tarso-basitarsus length (Fig. 17). *Legs I-IV*: I antenniform and tarso-basitarsus proportion 19:4:5:4:3:20 (Fig. 24). Femur IV 2.9 times as long as wide (Fig. 18).

Paralectotype ♀ body colouration as in ♂, anterior median process more pointed, acute and bent downwards, setation on cephalothorax not clear, but anterior sternum with 4 setae and a pair of long sternapophysial setae, posterior sternum not sclerotized and with only 4 setae; *Flagellum*: broken on anterior tip, remaining portion with two faint annuli, genital sternite (V) with 6 scattered setae, spermathecae not dissected, (Diagram after Cokendolpher, unpubl. data) (Fig. 20), *Pedipalp*: produced but not as pointed as in male, *Legs* I antenniform, tarso-basitarsus proportion 20:3:4:4:5:10. Femur IV 2.65 times longer than wide. Leg formula 1423.

Table 3: Measurements (in mm) for ♂ "*Schizomus*" *lunatus* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	0.77	0.51	0.55	0.58	1.65
Femur	1.82	1.76	3.30	2.97	4.18
Patella	1.87	5.28	1.76	1.54	1.76
Tibia	1.82	-	2.64	1.27	2.86
Basitarsus		-	2.15	1.43	3.14
Tarsus	1.10	-	1.38	1.32	2.87
Total	7.38	-	11.78	9.11	16.46

Table 4: Measurements in mm for ♀ "*Schizomus*" *lunatus* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	1.54	1.16	0.55	0.72	0.83
Femur	1.65	3.30	2.31	2.20	3.36
Patella	1.60	4.18	1.49	1.10	1.49
Tibia	1.32	2.92	1.43	1.27	2.37
Basitarsus			1.49	1.05	1.87
Tarsus	0.99	2.43	1.10	0.88	1.27
Total	7.10	13.99	8.37	7.22	11.19

Type data: **Lectotype** ♂, **Paralectotype** ♀, from Indian Museum Compound and Tollygunge, Calcutta, Coll. F.H. Gravely, date unknown, deposited in National Zoological Collection, ZSI, Kolkata Regn. No. not available.

Remarks: Reddell and Cokendolpher (1995) have retained 37 species, new as well as some undescribed, under the genus "*Schizomus*" including the species *Schizomus lunatus* Gravely, stating "in the absence of adults, study of the female genitalia, or taxonomic revision, these species cannot be placed in any recognized genus." For such species, the generic name *Schizomus* is placed in inverted commas. So the species is being retained as "*Schizomus*" *lunatus* Gravely at present.

3. ***Notozomus perplexus*** **(Gravely) comb. nov.** (Figs 25-37)

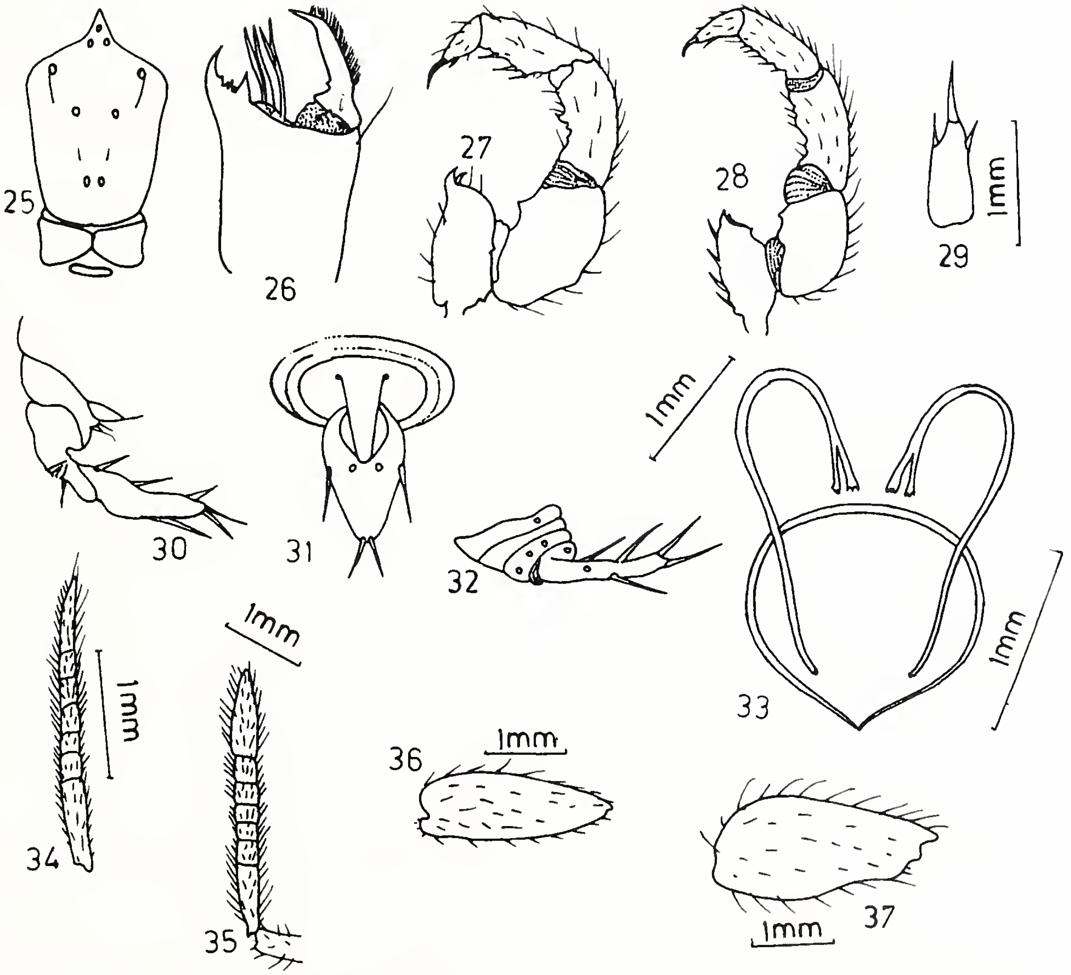
1915a. *Schizomus (Trithyreus) perplexus* Gravely, *Rec. Indian Mus. 11*: 383-385.

1961. *Trithyreus perplexus* Remy, *Bull. de Mus. Natl. de Hist. Nat. 2e Ser. 33*: 206-14

1995. "*Schizomus*" *perplexus* Reddell and Cokendolpher, *Texas Mem. Mus Speleol. Monogr. No. 4*: 4, 20 and 53,

General: ♀ Total length 4.50 mm, delicate, yellowish-brown, pale on appendages (Table 5).

Cephalothorax: Propeltidium longer than wide, median surface raised and appearing convex medially, lateral margins narrowing anteriorly and ending in a sub-conical process, not very acute, armed with an anterior and three pairs of dorsal setae; a pair of lateral ocelli not very distinct, mesopeltidia distinct, placed between carapace and metapeltidium, metapeltidium divided medially on posterior portion, anterior margin parallel to propeltidium but rounded on posterior lateral margins (Fig. 25); anterior sternum broad, pointing posteriorly, setae on anterior sternum 8 and a pair of long sternapophysial



Figs 25-37: *Notozomus perplexus* (Gravely) comb. nov., 25. Pro, meso and metapeltidium, dorsal view, 26. Chelicera, outer view, 27. Pedipalp (♀), lateral (mesal), view, 28. Pedipalp (♂), lateral (mesal) view, 29. Basitarsus-tarsus (♀), lateral view, 30. Flagellum (♂), lateral view, 31. Flagellum (♂), ventral view, 32. Flagellum (♀), lateral view, 33. Spermathecae, ventral view, 34. Tarso-basitarsus I (♀), lateral view, 35. Tarso-basitarsus I (♂), lateral view, 36. Femur IV (♂), lateral view, 37. Femur IV (♀), lateral view

setae present, posterior sternum small, sub-triangular but setal numbers and position not clear.

Abdomen: All tergites smooth, tergite I much narrower and with 2 distal setae, tergites II-IX with 2 dorsal and 2 lateral setae, segment X with 8 + 8 = 16, XI with 6 + 6 = 12 and XII with 4 + 4 = 8 setae, *flagellum*: narrow, shaft with 3 annuli, 0.984 mm long and 0.164 mm wide, with 7 strong, stout setae (Fig. 32). *Spermathecae*: Consisting of only a pair of bifurcated, much elongated and incurved stalks, each branch ending in a sclerotized bulb, flat on distal marginal ends (Fig. 33).

Appendages: *Chelicera*: basal segment smooth, setae present as 1-4, 2-5, 3-4, 4-3 5-7 and 6-1, immovable finger with a strong basal tooth without a notch and armed with 3 minute teeth on inner margin, movable finger smooth without serrula and with a file of short setae on inner margin (Fig. 26); *Pedipalp*: with trochanter produced, with blunt anterior process, coxa flat with 6-7 distally pointed strong spines on the margin, femur curved, as long as coxa, bearing 1 or 2 minute tubercles on inner margin, patella a little longer than femur, smooth, tibia almost as long as patella, narrowed distally and provided with a few small spines, basitarsus almost half as long as tibia, narrowed distally, single sub-apical spur located ventrally on tarso-basitarsus, claw not even 1/3rd as long as upper margin of tarso-basitarsus (Fig. 27); *Legs* I-IV: I antenniform, tarso-basitarsus proportion 11:4:4:3:4:5:21 not very long but comparatively thin (Fig. 35); Coxa II bearing a short, sharp spur-like process directed anterio-laterally, femur IV slightly more than 2.34 times longer than wide. Legs II-IV each with three claws.

Paralectotype: ♂ Cephalothorax finely granular on anterior side, otherwise same as in female; *Pedipalp*: much stronger and stouter; trochanter laterally flat, ventral margin straight and distally bearing a pair of uneven but strong spurs; femur also flattened, shorter than trochanter, bearing a few short denticulate spines on inner margin; patella almost as long as femur, bearing a pair of short tubercles on inner surface; tibia as long as but wider than patella, proximal inner portion elevated and provided with a few delicate setae; single elongated spur on inner surface of tarso-basitarsus, claw as long as half the upper margin of tarso-basitarsus (Figs 28, 29). *Leg I*: antenniform, tarso-basitarsus proportion 14:5:4:5:4:5:22 (Fig. 34). Femur IV 2.8 times longer than wide (Fig. 37); Leg formula 1423. *Flagellum*: 1.03 mm long, 3-annulated, distal annulus flat, expanded laterally, like an arrow (Fig. 30), first annulus without setae, serves as stalk, distal two annuli not distinctly separated, covered with 10-12 major setae, distal surface flat with a median pore and ventral surface convex in the middle (Fig. 31).

Type data: 1 ♀, **Lectotype** (studied), 7 ♀ ♀ **Paralectotypes** (2 ♀ ♀ without flagellum), 3 ♂ ♂ **Paralectotypes** (1 ♂ without flagellum), numerous immature specimens in separate vial stating *S. (Th.) buxtoni* Gravely, comments are not clear. All collected by B.H. Buxton, date unknown; Locality: Polonurwa, Sri Lanka (Ceylon), all deposited in National Zoological Collection, Zoological Survey of India, Kolkata, Regn. No.: not available.

Table 5: Measurements (in mm) for ♂ *Notozomus perplexus* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	1.70	0.50	0.40	0.30	0.50
Femur	1.70	2.40	1.40	1.60	1.70
Patella	1.30	2.70	0.60	0.80	1.90
Tibia	1.20	2.00	0.60	1.10	1.70
Basitarsus	0.80	1.80	1.00	0.80	1.10
Tarsus			0.80	0.70	0.90
Total	6.70	9.40	4.80	5.30	7.80

Remark: Since the characters and illustrations given for the genus *Notozomus* Harvey by Reddell and Cokendolpher (1995) agree with *Schizomus perplexus* Gravely, specially in the basic structure of the spermathecae, the author proposes to transfer the species to genus *Notozomus* Harvey as *Notozomus perplexus* (Gravely) comb. nov.

4. **“*Schizomus*” *greeni* Gravely** (Figs 38-44)

1912. *Schizomus* (*Trithyreus*) *greeni* Gravely, *Rec. Indian Mus. 12*: 108-109.

1974a. *Trithyreus greeni* Brignoli, *Acad. Nazl. d' Lin. Prob. Att. d Sci & Cult. Quad. 17(2)*: 143-152.

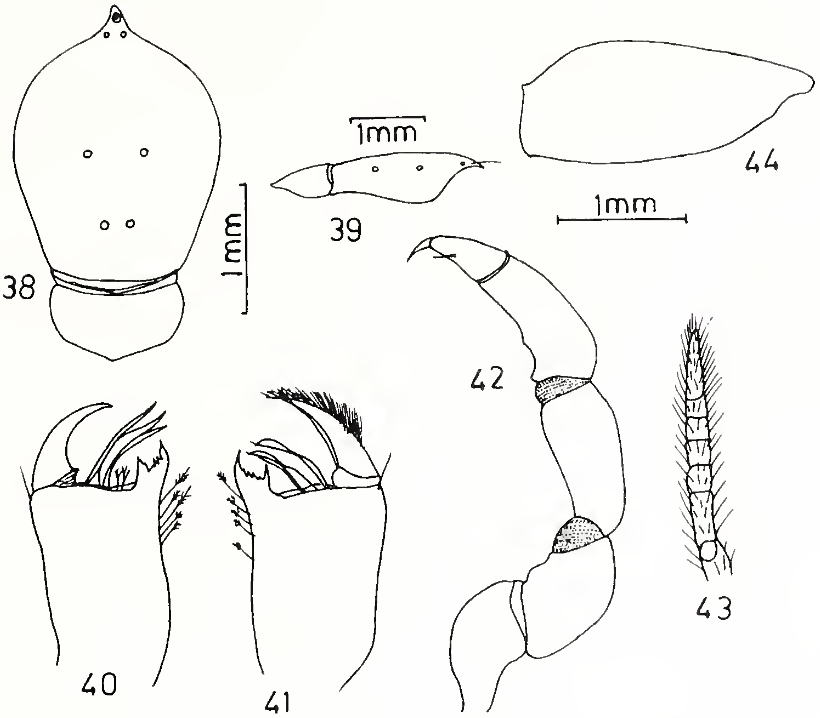
1995. *Schizomus greeni* Reddell & Cokendolpher, *Texas Mem. Mus. Speleol. Monogr. No. 4*: 48.

General: ♀ Yellowish body, paler on appendages, carapace twice as long as wide, ocelli absent, pedipalp delicate, legs normal and flagellum broken.

Measurements (in mm): Total length 6.80, carapace length 2.80, carapace width 1.10, abdomen length 4.00, flagellum broken, could not be measured (Table 6).

Cephalothorax: Propeltidium more than twice as long as wide, much wider at anterior end, dorsal surface convex, more prominently on anterior side and ending anteriorly in a sub-conical process (Fig. 38), 1 anterior and 2 dorsal pairs of setae on propeltidium, no ocelli present, mesopeltidia narrow and not very clear, metapeltidia placed close to posterior margin of propeltidium, parallel and also undivided medially, but a faint median suture noticeable at 1/3rd distance from anterior end and 1/3rd distance from posterior end.

Abdomen: Tergite I narrowed anteriorly, tergites II-IX smooth, setation not clear except for one pair of median setae on each tergite, segments X-XII contracted, may be due to preservation, flagellum short, 3-segmented. Spermathecae not observed, specimen probably immature.



Figs 38-44: *Schizomus greeni* Gravely, 38. Pro, meso and metapeltidium, dorsal view, 39. Pro, meso and metapeltidium, lateral view, 40. Chelicera, inner view, 41. Chelicera, outer view, 42. Pedipalp, lateral (mesal), view, 43. Tarso-basitarsus I, lateral view, 44. Femur IV, lateral view

Appendages: *Chelicera*: with setae 1-4, 2-?, 3-5, 4-2, 5-? and 6-1, immovable finger with 3 minute teeth between 2 large teeth (Figs 40, 41), movable finger smooth with no teeth or serrula, but armed with a row of short setae on mesal margin. *Pedipalp*: delicate, not at all strong and stout, trochanter margin not straight or provided with spur, and also not very flat laterally; femur smooth, almost as long as trochanter; patella tubular, as long as preceding segment, smooth; tibia about as long as patella, smooth and tapering distally; tarso-basitarsus with a small delicate basal spine, claw also short and delicate, not even 1/4th of exterior basitarsal marginal length, only mesal spur prominent (Fig. 42). *Legs* I-IV: I antenniform and much longer (Fig. 43), II & IV with femora much flattened and femur IV more than twice as long as wide (Fig. 44). Leg formula 1423.

Table 6: Measurements (in mm) for ♀ "*Schizomus*" *greeni* Gravely

	Pedipalp	Legs I	II	III	IV
Trochanter	0.90	0.60	0.40	0.60	0.65
Femur	0.80	1.80	1.60	1.40	1.50
Patella	1.10	2.30	0.80	0.60	0.90
Tibia	0.80	1.70	1.00	0.80	1.10
Basitarsus	0.60	1.00	0.90	0.90	1.30
Tarsus		0.80	0.70	0.70	0.90
Total	4.20	8.20	5.40	5.00	6.35

Type data: 1♀ **Lectotype** from under a stone at Ambalagonda, S. Province, Sri Lanka (Ceylon); one specimen from compound of the Museum, Colombo, 20.vii.1912. Coll. E.E. Green; deposited in National Zoological Collection, ZSI, Kolkata. Regn. No.: Not available. ♂ unknown.

Remarks: Since the author could not study the genitalia in detail, as the specimen was probably an immature female he retains the species as "*Schizomus*" *greeni* Gravely at present.

5. "***Schizomus***" ***vittatus*** Gravely (Figs 45-47)

1911b. *Schizomus (Trithyreus) vittatus* Gravely, *Spolia zeylanica 8*: 135-140.

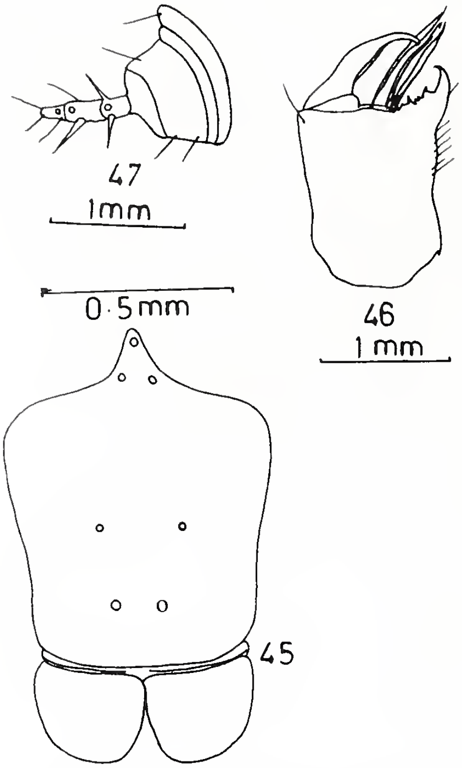
1972. *Trithyreus vittatus* Shimojana, *Iden, Tokyo 26*: 100-106.

1995. "*Schizomus*" *vittatus* Reddell & Cokendolpher, *Texas Mem. Mus. Speleol. Monogr. No. 4*: 55-56.

No description provided, diagrams only for cephalothorax, chelicera and flagellum given for ♀ specimen (cotype, probably immature specimen).

Type data: 6♀♀ cotypes from Royal Botanical Garden, Peradeniya and Paralenia, Sri Lanka (Ceylon); date unknown, Coll. F.H. Gravely, National Zoological Collection, ZSI, Kolkata, Regn. No.: Not available.

Remarks: The author was provided only 1♀ specimen,



Figs 45-47: *Schizomus vittatus* Gravely,
45. Pro, meso and metapeltidium, dorsal view,
46. Chelicera, inner view, 47. Flagellum (E), lateral view

which was in fragile condition and probably an immature, so he was unable to study this species in detail, particularly the genitalia. Therefore he retains it as "*Schizomus*" *vittatus* Gravely.

Burmezomus gen. nov.

Diagnosis: Anterior process of propeltidium beak-like, bent and bearing 3 setae, one in front and followed by a pair of setae, eyespots present, metapeltidium undivided, trochanter strongly produced anteriorly and broadly connected to femur, trochanter with strong mesal spur, femur curved on exterior portion without spinose setae, patella not much curved but bearing 3 tubercles on interior margin, tibia without spur but tarsus bearing tarsal spur, movable cheliceral finger without serrula, anterodorsal margin of femur IV produced at an angle more than 90°, female flagellum single, without any segment, spermathecae with uneven number of banded, rod-like structures ending in pointed or cup shape, gonopod short and pointed.

Type species: *Schizomus cavernicola* (Gravely)

Distribution: Khayon caves near Moulmain, Myanmar (Burma).

Etymology: The generic name derived from Burma and the Burmese people, suffixing the generic name *zomus*. The gender is masculine.

6. *Burmezomus cavernicola* (Gravely) comb. nov.

(Figs 48-56)

1912. *Schizomus* (s. st.) *cavernicola* Gravely, *Rec. Indian Mus. 7*: 107-109.

1977. *Schizomus cavernicola* Rowland & Reddell, *Assoc. Mexican Cave Studies Bull. 6*: 79-102.

1995. *Schizomus cavernicola*: Reddell & Cokendolpher, *Texas Mem. Mus. Speleol. Monogr. No. 4*: 48.

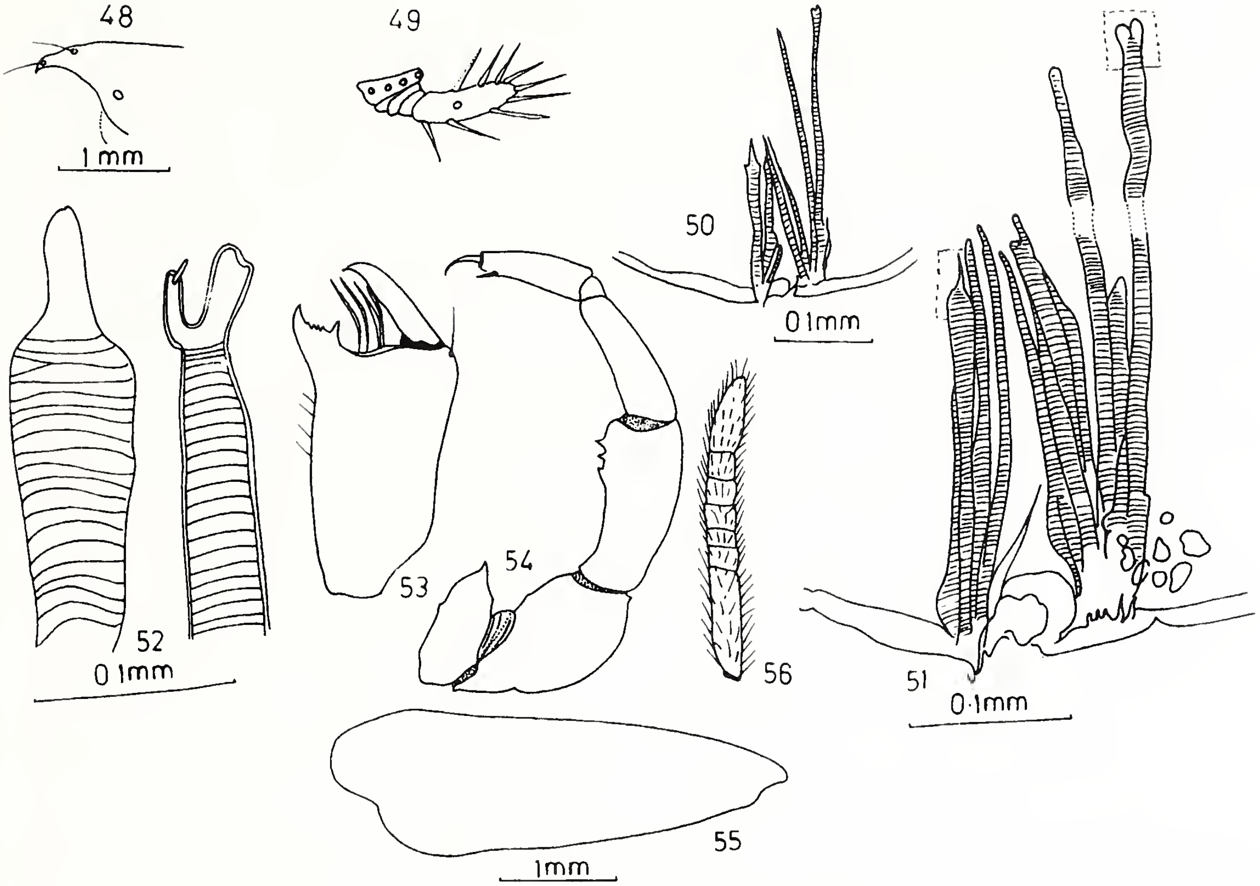
General: **Lectotype** ♀ body greyish-yellow, lighter on appendages except brownish red tips, pedipalp, tarsus, claws and stout spines.

Measurements (in mm): Total length 6.46; Cephalothorax length 2.24, Cephalothorax width 1.23, abdomen length 3.66, flagellum length 0.56 and width 0.2.

Cephalothorax: Propeltidium beaked anterior, beak acutely bent forward, supported with one long seta followed by a pair of setae at the base of beak, 3 pairs of dorsal setae (Fig. 48). A distinct pair of white eyespots present on anterio-lateral portion (Fig. 48). Mesopeltidia very narrow and separated medially. Metapeltidium undivided, almost rectangular, slightly longer than wide, provided with a pair of posterior median setae.

Abdomen: Tergites I-IX smooth, each with a pair of median setae, other setae not clear, segments X-XII telescoped, setae dropped, except for a few dorsal setae on segment X. Sternites also smooth, except for 7-8 setae on segment I, no setation clearly seen, anterior sternum with 6 setae visible and a pair of long sternapophysial setae, posterior sternum not much sclerotized and with 5-6 small reddish setae. *Flagellum*: single annulus, short 2.8 times longer than wide, *3d, 3vl and 2v* pairs of setae (Fig. 49), Spermathecae consist of elongated bar-like structures of uneven length and numbers, some tapering, pointed distally and some with cup-shaped distal end, all evenly banded (Fig. 50-52).

Appendages: *Chelicera*: basal segment smooth with setal types 1-4, 2-2, 3-1, 4-?, 5-4 and 6-1, fixed finger with 5 serrulated sharply pointed teeth between two large outer teeth, movable finger smooth without teeth or serrula on inner margin (Fig. 53). *Pedipalp*: robust, produced anteriorly into a pointed spine on anterior portion (Fig. 54), femur and patella equal in length, but femur wider than patella, tibia shorter than patella and narrowed distally, tarso-basitarsus shorter than patella and tarsal claw almost half as long as basitarsus. *Legs I-IV*: measurement as in Table 7, I antenniform (Fig. 56), Femur IV slightly less than 3 times longer than wide (Fig. 55). Leg formula 1423.



Figs 48-56: *Burmezomus cavernicola* (Gravely) comb. nov., 48. Anterior portion of propeltidium, lateral view, 49. Flagellum (♀), lateral view, 50. Spermathecae, ventral view, 51. Spermathecae, ventral view (enlarged), 52. Spermathecal rods, distal portions, ventral view (enlarged), 53. Chelicera, inner view, 54. Pedipalp, lateral (mesal) view, 55. Femur IV, lateral view, 56. Tarso-basitarsus, lateral view

Table 7: Measurements (in mm) for ♀ of *Burmezomus cavernicola* (Gravely)

	Pedipalp	Legs I	II	III	IV
Trochanter	0.65	0.52	0.22	0.30	0.56
Femur	0.82	2.11	1.55	1.29	2.28
Patella	0.77	2.41	0.56	0.47	0.82
Tibia	0.43	1.98	0.77	0.65	1.38
Basitarsus			0.82	0.68	1.12
Tarsus	0.52	1.38	0.60	0.62	0.86
Total	3.19	8.40	4.52	4.01	7.02

Type data: 2♀♀ **Lectotype**, in depths of big dark cave (the famous Khayon cave) near Moulmain, Myanmar (= Burma). Coll. F.H. Gravely, 17.xi - 4.xii.1911, deposited at National Collection, ZSI, Kolkata, Regn. No. 2161/18, ♂ unknown.

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DETERMINING THE RELATIONSHIP BETWEEN BIOMASS CONSUMED AND SCATS PRODUCED IN CAPTIVE ASIATIC LIONS (*PANTHERA LEO PERSICA*) AND LEOPARDS (*PANTHERA PARDUS*)[1]

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Feeding trials on captive adult Asiatic Lion (*Panthera leo persica*) and Leopard (*Panthera pardus*) were conducted at the Sakharbaug zoo, Junagadh (India) to establish a relationship between the amount of food consumed and the scats produced. Lions (ave. body mass = 100 kg.) and Leopards (ave. body mass = 50 kg) fed *ad libitum* on buffalo meat consumed an average of 6% and 8% of their total body mass respectively. Biomass ingested by Leopard was significantly correlated with the total dry weight of scats ($p = 0.01$, $r^2 = 0.75$), but not with the number of scats produced ($r^2 = 0.028$). However, a relationship was noted between the amount given and biomass consumed per scat ($p = 0.04$ $r^2 = 0.53$). For lions, no significant correlation was seen, either in the number of scats produced or the dry weight of scats, with the amount consumed. Also, the biomass consumed per scat was not correlated with the amount given.

Key words: Feeding trials, scat weight, scat number

INTRODUCTION

Calculating the percentage of scats containing different prey items, or percent occurrence of prey items is the most commonly used method for quantifying diet from scat. This method has several limitations. It tends to over-represent larger prey, as they induce the production of a greater number of scats (Jones and Smith 1979; Weaver and Hoffman 1979; Ackerman *et al.* 1984; Reynolds and Aebischer 1991). However, Floyd *et al.* (1978) concluded that smaller prey would be over-represented in terms of weight, but under-represented in numbers, as small prey species are known to produce more indigestible matter, such as hair, due to a higher surface to volume ratio than larger prey species. Nevertheless, frequency or percent occurrence of prey species in scats alone may not be a reliable method to quantify predator diet (Floyd *et al.* 1978; Weaver and Hoffman 1979; Ackerman *et al.* 1984). To overcome this problem, as well as to estimate fresh-weight intake, feeding trials on captive wolves (Floyd *et al.* 1978), coyotes (Weaver and Hoffman 1979) and cougars (Ackerman *et al.* 1984) were conducted and correction factors were obtained from regressions of food consumed to scat produced. This can be applied to the data obtained as percentage of scats having a prey item, to obtain reliable estimates of biomass consumed by the predator (Floyd *et al.* 1978; Weaver and Hoffman 1979; Ackerman *et al.* 1984).

We conducted feeding trials to establish the relationship between biomass consumed and scat produced in captive Asiatic Lions and Leopards.

METHODS

Feeding trials were conducted during August 1993. Eight captive adult Lions and Leopards each were chosen for the feeding trials at the Sakharbaug zoo in Junagadh, Gujarat and each animal was housed in a separate cage. Food was withdrawn for 48 hours before commencing the feeding trials to remove the effect of the previous diet, and the scats from the earlier diet were rejected. As buffalo meat was the regular diet of the cats at the zoo, the experimental animals were also fed buffalo meat along with skin and hair. The Lions were given 6 to 20 kg meat and Leopards 3 to 10 kg. The animals were randomly fed 3/6 kg to 10/20 kg of meat for one day. Water was provided *ad libitum*. After 24 hours, the unconsumed meat was weighed to determine the amount consumed by individuals. Food was again withdrawn until scat production ceased. All scats produced during this period were collected, and oven dried at 70 °C for a week, and weighed to the nearest 0.1 gm.

RESULTS

The captive Asiatic Lions and Leopards which had been unfed for 48 hrs consumed a mean of 6.1 kg (Range: 1-15 kg) and 4.3 kg (Range: 1.5-6.5 kg) respectively. This amounts to 6% and 8% of the body mass of the lion and leopard respectively per day. The maximum meat consumed by both cats equals 10% to 12% of their body weights, per day.

Meat consumption was proportional to the amount available (Fig. 1). This relationship was stronger in case of

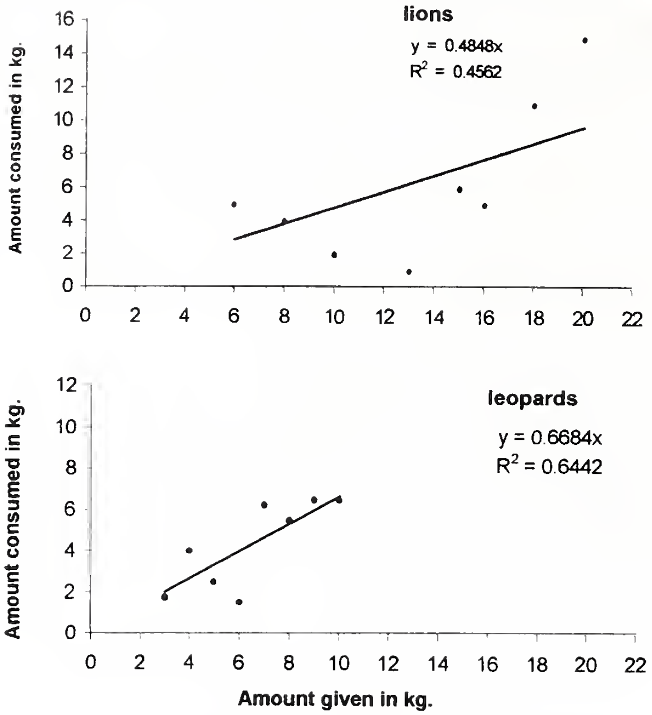

Fig. 1: Relationship between the amount of food given to Asiatic Lions and Leopards and the amount consumed by them

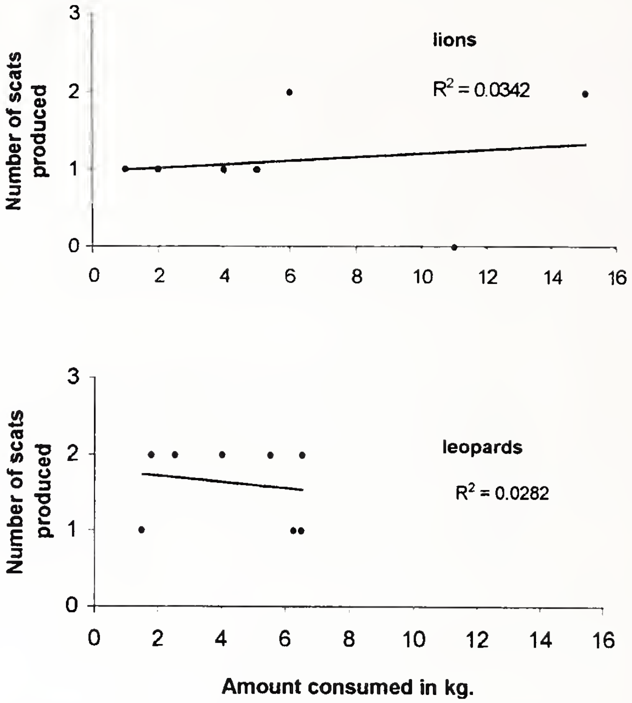

Fig. 2: Relationship between amount of meat consumed by Asiatic Lions and Leopards and the number of scats produced

leopards (Fig. 1) ($r^2 = 0.64$, $p = 0.01$) than in lions ($r^2 = 0.45$, $p = 0.05$). However, consumption seemed to stabilize around 6 to 6.5 kg for leopards when given more than 8 kg of meat. In case of lions, some individuals consumed less meat irrespective of the amount supplied, making the relationship weaker.

In both the cats, the relationship between biomass ingested and the number of scats produced did not yield much information, as the maximum number of scats produced was two for 2 kg as well as 6 kg of meat consumed (Fig. 2). However, for leopards, biomass per scat was related to amount given by the equation $y = 0.6533x - 1.1994$ ($r^2 = 0.53$, $p = 0.04$) (Fig. 3). This was not seen in lions. The biomass ingested by leopard was significantly correlated with the total dry weight of scats produced (Fig. 4), but lions did not show a correlation between biomass ingested and total dry weight of scats.

DISCUSSION

The amount of food consumed by captive large felines agrees with other studies in the wild where felids and canids consumed on an average food 7% to 10% of their body mass (Golley *et al.* 1965; Kolenosky 1972; Nellis *et al.* 1972; Johnsingh 1983; Caro 1989; Aldama 1991; Jhala 1991; Stander *et al.* 1997).

Studies on wolf, coyote, and cougars have shown a significant relationship between biomass ingested and the number of scats produced when given wild prey (Floyd *et al.* 1978, Weaver and Hoffman 1979, Ackerman *et al.* 1984). However, the slope for the regression of biomass per scat and amount given in leopards was steeper than estimated for cougars (Ackerman *et al.* 1984) and wolves (Floyd *et al.* 1978). This suggests that leopards produced fewer (maximum two), but heavier scats than cougars and wolves. Ackerman *et al.* (1984) observed that wolves produced approximately four times more scats than cougars, but the scat weight was higher in cougars than wolves. However, Ackerman *et al.* (1984) and Floyd *et al.* (1978) estimated only wet weight of scats while we estimated dry weights, these could not be compared. The difference between the equations generated for cougars and leopards could also be due to the fact that we could give the cats only one prey type, while the other studies (Floyd *et al.* 1978; Ackerman *et al.* 1984) gave several wild prey types. Hence, this trend with leopards needs to be validated by providing them with natural prey.

Lions showed a greater amount of grooming as indicated from remains of self-hair in the scats of non-experimental animals (which were given dressed meat). This could be the reason for the lack of correlation in the case of lions.

Some major problems that can be expected during feeding trials with zoo-bred animals are:

1. Animals may not feed on meat other than the type they are used to.
2. Animals may reject skin and hair totally.
3. Consumption of self-hair by predators while grooming could lead to erroneous results from scat analysis.

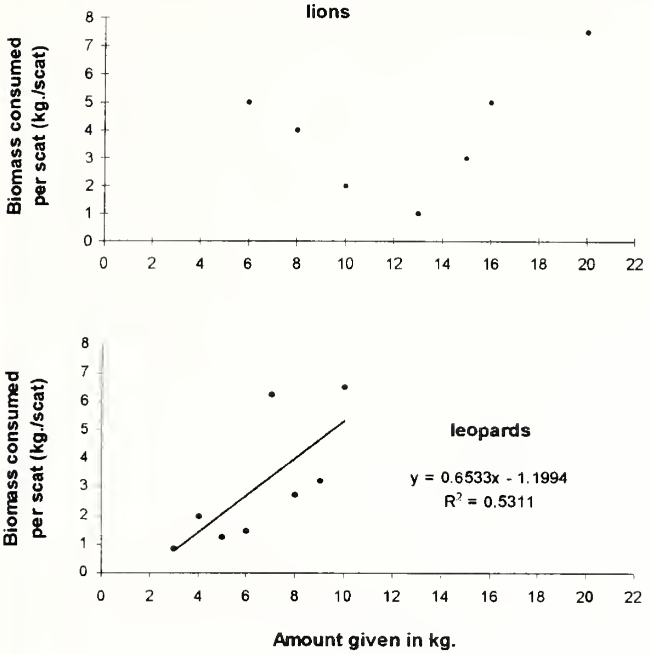

Fig. 3: Relationship between the amount of food given to Asiatic Lions and Leopards and the biomass consumed per scat

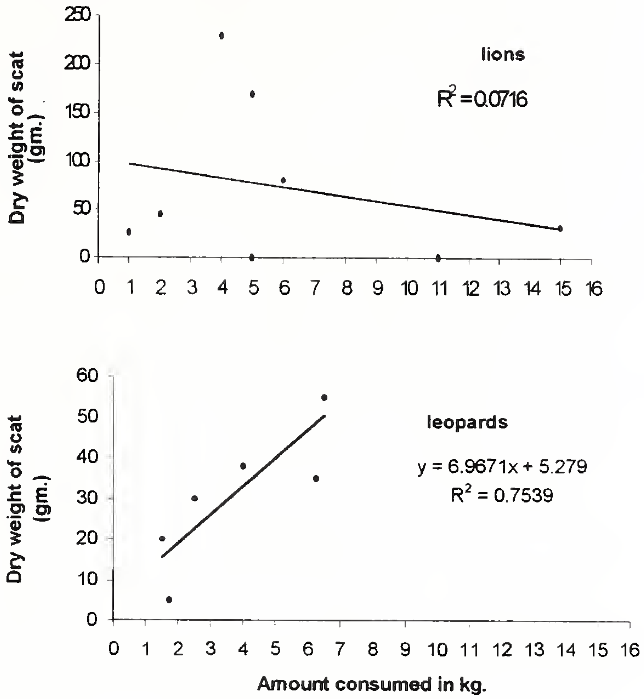

Fig. 4: Relationship between amount of meat consumed by Asiatic Lions and Leopards and the dry weight of scats

CONCLUSIONS

1. Captive Asiatic Lions and Leopards consumed food between 5% to 10% of their body mass.
2. Leopards consumed food in proportion to availability. This was not seen in Asiatic Lions.
3. Total number of scats produced is not a good indicator of the amount of food consumed for both Asiatic Lions and Leopards.
4. The dry weight of scats showed a strong relation to the amount of food consumed, in case of leopards but not lions.
5. Biomass per scat was related to the amount of food given in the case of leopards but not in lions. This trend for leopards needs to be validated through feeding trials with natural prey.

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NUTRITIONAL STATUS OF FERNS AND THEIR RELATION TO INSECT INFESTATION FROM DARJEELING FOOTHILLS AND PLAINS[1]

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Some dietary parameters of five common fern species from the Darjeeling foothills and plains were analysed. Biomolecules like proteins, carbohydrates and lipids, as well as phenols, fibres and moisture content of mature fronds were studied to understand the basis of colonization by fern-attacking insects. High moisture content, along with high nutritive protein and carbohydrate levels of mature fronds of *Diplazium esculentum* (Retz.) Sw. and *Christella crinipes* (Hk.) Holt appeared to be important factors in determining the palatability and infestation of the fern species by insect herbivores.

Key words: Nutritional status, host fern, insect herbivory

INTRODUCTION

Ferns are apparently found to be underutilized as food plants by insect herbivores (Soo Hoo and Fraenkel 1964, Eastop 1973, Hendrix 1980, Cooper-Driver 1978). However, intensive studies on insect-fern relationships show that some fern species are palatable and well exploited by insects as food plant. Thus, the assumption that ferns are underutilized may be an artifact of inadequate sampling (Hendrix and Marquis 1983). Nevertheless, it has been adequately documented that certain chemicals (Karlson and Bode 1969, Daniel and Chandrasekar 1986), as well as physical factors (Soo Hoo and Fraenkel 1964) determine the resistance and non-palatability of ferns.

In a study on ferns from the foothills and plains of Darjeeling, it was noted that the common ferns, *Diplazium esculentum* (Retz.) Sw. and *Christella crinipes* (Hk.) Holt were the most preferred food plants. While a meagre infestation of *Lindsaea ensifolia* Sw. and *Microlepia speluncae* (L.) Moore has been recorded, no insect herbivores have so far been observed on *Dicranopteris linearis* (Brum. F.) Underus. (Mukhopadhyay and Thapa 1994). To understand the preference and colonization by insect herbivores, five common fern species were analysed for proteins, carbohydrates, lipids and fibres, moisture and total phenols.

METHODS

Nutritive carbohydrate of dry fern powder of middle-aged fronds was estimated using the techniques of Plummer (1979) and Ananthakrishnan (1990). Protein was extracted as per Draper (1976), and estimated as in Lowry *et al.* (1951). Total lipid was estimated by the standard gravimetric technique using petroleum ether as solvent. Total phenol was assayed from the ethanol extract as per Hori (1974). Moisture content was estimated by drying the fronds in an oven at 50 °C for 48 hrs. Fibre (non-extractable components) was assayed as per Rowell *et al.* (1983).

RESULTS

The biochemical analysis of the fern species revealed that although the total storage protein was highest in *Christella crinipes* and *Dicranopteris linearis*, the nutritionally higher quality protein, albumin and globulin, far exceeded in the former. Total protein in *Diplazium esculentum* followed close behind, with a fair amount of albumin and globulin. Total protein was least in *Microlepia speluncae*, and marginally higher in *Lindsaea ensifolia*. Glutelin, second amongst nutritive proteins (Slansky and Panizzi 1987), was highest in *Diplazium esculentum*, and considerably low for the other fern species. Prolamine, the poorest of storage proteins, was highest in *Dicranopteris linearis*, followed by *Lindsaea ensifolia*, where it was almost half that of the highest value. In the other fern species, the value was almost equal to that of *L. ensifolia* (Table 1).

Total carbohydrate comprised monosaccharides and oligosaccharides, and starch. They were highest in *L. ensifolia* closely followed by *Diplazium esculentum* and *Christella crinipes*. The level was comparatively low in *Microlepia speluncae* and the lowest in *Dicranopteris linearis*. The quantity of both the mono- and oligosaccharide is less than starch in all the species. Maximum starch was found in *Christella crinipes* followed by *Diplazium esculentum*. It was comparatively less in the other species (Table 1). Total lipid was highest in *Lindsaea ensifolia*, while it was lowest in *Dicranopteris linearis*. Total lipid was almost half of *Lindsaea ensifolia* in *Christella crinipes* followed by *D. esculentum* and *M. speluncae* (Table 1).

Table 1: Comparison of basic nutritional components (mg/g) of five fern species (Mean ±SE)

Fern species	Albumin + Globulin	Glutelin	Prolamine	Total Protein	Monosaccharide + Oligosaccharide	Starch	Total Carbohydrate	Total Lipid
Diplazium esculentum	96.85 ±0.66	68.09 ±0.23	19.37 ±0.05	184.32 ±0.58	96.69 ±0.64	126.9 ±0.34	223.65 ±0.90	23.03 ± 0.85
Christella crinipes	163.26 ±1.21	10.12 ±0.13	18.17 ±0.02	190.36 ±0.66	89.78 ±0.51	130.9 ±0.05	220.76 ±0.52	36.52 ±1.17
Lindsaea ensifolia	69.18 ±0.40	8.40 ±0.13	36.37 ±0.02	113.97 ±0.52	133.5 ±0.44	94.66 ±0.21	228.22 ±0.97	64.10 ±1.08
Microlepia speluncae	50.20 ±0.48	9.55 ±0.08	15.99 ±0.04	75.77 ±0.46	85.96 ±0.43	104.5 ±0.19	190.48 ±0.57	21.80 ±0.35
Dicranopteris linearis	106.04 ±0.73	3.77 ±0.03	80.38 ±0.07	190.21 ±0.71	53.83 ±0.09	90.89 ±0.14	144.73 ±0.17	7.75 ±0.24

Percentage of moisture was highest in *Diplazium esculentum*, closely followed by *Microlepia speluncae*. The moisture content of *Christella crinipes* and *Lindsaea ensifolia* was slightly reduced with an overlapping value, while *Dicranopteris linearis* had the least. Total phenol was estimated to be highest in *Lindsaea ensifolia*, followed by *Christella crinipes*, *Diplazium esculentum* and *Dicranopteris linearis*. *Microlepia speluncae* had a remarkably low phenol content. The percentage of fibre (non-extractable components) was estimated to be the highest in *Lindsaea ensifolia* and lowest in *Dicranopteris linearis*. The fibre content of *Diplazium esculentum* and *Microlepia speluncae* had intermediate and overlapping ranges (Table 2).

Observation of the fern vegetation from the foothills and plains of Darjeeling have confirmed an association of 60 insect species from the orders Lepidoptera (12), Coleoptera (19), Hemiptera (20), Hymenoptera (4), Orthoptera (2), Thysanoptera (2) and Diptera (1) (Mukhopadhyay and Thapa 1994). Of these, 16 species were regular fern feeders, suckers and miners. The fern species preferred and attacked by most of the insects was *Diplazium esculentum*, followed by *Christella crinipes*. The other species were less attacked or colonized by only a few specialized insect herbivores.

Table 2. Comparison of some dietary factors (Mean ±SE) and percentage occurrence of insect-herbivores on five fern species

Fern species	Total (mg/g)	Water (%)	Fibre (%)	Insect occurrence (%)
Diplazium esculentum	6.90 ±0.20	81.30 ±0.29	50.47 ±0.27	87.50
Christella crinipes	7.46 ±0.01	72.13 ±0.59	54.43 ±0.38	43.75
Lindsaea ensifolia	8.15 ±0.35	71.84 ±0.54	56.07 ±0.37	6.25
Microlepia speluncae	1.85 ±0.02	79.86 ±0.41	50.12 ±0.35	6.25
Dicranopteris linearis	6.68 ±0.03	57.83 ±0.60	44.39 ±0.35	0

DISCUSSION

In ferns, higher concentration of protein and nitrogen plays a significant synergistic role with other chemicals in attracting jassids and aphids (Daniel and Chandrasekhar 1986). Species like *Lindsaea ensifolia* and *Microlepia speluncae* with low levels of total protein largely remained unexploited by insects. *Dicranopteris linearis* with high total protein was possibly unpalatable because of its low carbohydrate and moisture content. A low concentration of carbohydrate has been reported to attract aphids (Daniel and Chandrasekar 1986). However, in this study, maximum insect attack was recorded on *Diplazium esculentum* and *Christella crinipes*, both with high total carbohydrates. This, however, was matched with high nutritional protein and low lipid levels.

Higher concentration of phenols may act as a repellent to insects because of their toxic effect, and this seemed true for *Lindsaea ensifolia*. This species and *Dicranopteris linearis* had the highest and the lowest fibre content respectively, but since both were underutilized, fibre content alone might not be responsible for the preference of fern as a food plant. Rowell *et al.* (1983) in their study on fern-insect fauna suggested that the chemical constituents of fern fronds, like nitrogen, phenol, tannin, and fibre, had little impact on their palatability. In the present study, a high percentage of moisture in *D. esculentum* along with enhanced protein and carbohydrate levels, might have been the deciding factors for its greater palatability (81.3%), and overexploitation by insects.

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ELEPHANT-HUMAN CONFLICT ON COMMUNITY LANDS IN GARO HILLS, NORTHEAST INDIA[1]

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An assessment of elephant-human conflict was carried out in the Garo hills in northeast India from November 1994 to September 1995. More than 85% (*c.* 3,605 sq. km) of the estimated elephant habitat is under the control of village communities. The predominant land-use pattern on these community lands is slash and burn agriculture, locally known as *jhum*. Our results showed that West Garo Hills district was the area most affected by elephant depredations. The landscape pattern resulting from the practice of slash and burn agriculture creates a mosaic of crop fields and forests. Since the forest patches in these areas are too small to support elephant groups for long periods of time, they move from one forest patch to another through crop fields and this leads to crop raiding, the main form of elephant-man conflict. The economic cost of damage caused in the region has been compared with similar studies in India. Reasons for crop raiding and the effectiveness of the current mitigation measures are discussed. The number of elephants killed by humans, either during crop raids or by poaching, has gone up in recent years. Recent developmental practices, like mining, which are incompatible with elephant conservation, are becoming widespread across the landscape, and are likely to increase the rates of elephant-human conflict. Recommendations to understand and reduce the conflict are outlined.

Key words: *Elephas maximus*, elephant-human conflict, crop raiding, shifting cultivation, northeast India

INTRODUCTION

The Asian elephant *Elephas maximus* in India occurs in five major fragmented populations totalling 17,000 to 22,000 individuals (Daniel 1980; Sukumar 1991). The elephant populations in south, central, and northwest India occur primarily in Forest Department controlled reserved forests, wildlife sanctuaries and national parks. However, in northeast India, a significant proportion (>40%) of the elephant population occurs in community lands, otherwise known as unclassified state forests. Most of elephant-human conflict studies in India have looked at elephants living within protected areas or areas controlled by the Forest Department, going out and causing crop depredations and loss of lives. However, in northeast India, elephants are living in areas controlled by local communities, and therefore traditional methods of management to reduce or mitigate the conflict are not feasible. This study is the first in India to analyse the problem of elephant-human conflict on community lands.

The Garo Hills, in Meghalaya, are a region of high elephant density and elephant-human conflict. An estimated 1,400 elephants occur over 3,605 sq. km of forest, of which only 15% is under the control of the Forest Department (Anon 1994). The 1993-94 Forest Department census estimated the total number of elephants on community lands, managed by tribals, to be over 600 (Anon 1994). This census was carried out when forests were cleared for cultivation. During such times elephants retreat to Forest Department controlled forests where disturbances are less, and therefore the estimate for community lands could be low.

The majority of the people living in the Garo Hills belong to the Garo tribe. Each Garo village has its own forests, demarcated by landmarks, such as streams and ridges. The control and management of the forest in every village is under the headman who acts in close coordination with the villagers (Singh 1994). The majority of the Garos subsist on shifting cultivation (*jhum*), a traditional method where a patch of forest is chosen and cleared by slashing the undergrowth and felling small trees and bamboo. The larger trees may be left intact. The felled vegetation is burnt when it is dry and the cleared area is divided into plots. Each plot is allotted to a family for cultivation. The area is cultivated for one or two years, after which it is abandoned and the people move on to another patch of forest to repeat the process. A special clause in the Indian Constitution allows them to practice *jhum* till date.

Approximately 760 sq. km of community forests is estimated to be under shifting cultivation or *jhum* in Meghalaya (Husain 1981). This has created a mosaic of secondary (bamboo and degraded scrub) forests interspersed with cultivation and primary forests. As a result, elephants often encounter crop fields, which have little or no protection, and raid them as the crops provide an easy source of highly nutritious food (Sukumar 1991). While attempting to prevent crop raiding, there are injuries and loss of human lives every year. To compensate this depredation, in 1984 the Forest Department started paying monetary compensation to the victims (Meghalaya Forest Department Office Memorandum No. For. 58/83/172 dated 25th April 1984). This measure has not contributed significantly towards reducing the problem of elephant-human conflict (see Results). Since the launching of Project Elephant, in 1991-1992, a Government of India project for the conservation of elephants in India, there is a renewed interest in implementing long-term measures to reduce elephant-human conflict.

Understanding the extent and intensity of the elephant-human conflict is important to formulate and implement mitigation measures (Thouless 1994; Desai and Krishnamurthy 1992) for this and similar areas in northeast India and Southeast Asia. The perspective of the local people needs to be assessed to come up with workable proposals. In this paper, we discuss the intensity of elephant-human conflict in Garo Hills and the efficacy of the various mitigation measures. Data was collected during a status survey of elephants in the region from November 1994 to September 1995.

The study area and land use in Garo Hills

The Garo Hills are one of the hill ranges in the northeast Indian state of Meghalaya, the other ranges being the Khasi Hills and Jaintia Hills. Garo Hills lie between 25° 9'-26° 1' N and 84° 49'-91° 2' E. The region includes three districts, namely the West Garo Hills, the East Garo Hills, and the South Garo Hills, covering a total area of 8,197 sq. km (Fig. 1). It is bordered on the west and the north by the Assam plains and on the south by the Bangladesh plains, while on the east the Garo Hills merge with the Khasi Hills. The average altitude is about 600 m and Nokrek peak, the highest point in Garo Hills, is 1,412 m (Momin 1984). The annual rainfall ranges between 1,500 and 3,500 mm. The human population density in the elephant areas of the three districts ranges from 23 to 106 /sq. km (Anon 1992). Haridasan and Rao (1984) have classified the vegetation into tropical evergreen forests, tropical moist deciduous forests, savannas, and bamboo forests. The last two categories are secondary forests characterised by abandoned *jhum* areas.

The predominant form of land use in the Garo Hills, as mentioned earlier, is *jhum*. Farmers grow rice, cotton, ginger, chillies, millets, tapioca and various types of gourds and vegetables. Intercropping and sequential harvesting are a characteristic feature. The area of each *jhum* plot ranges between 1 and 2.5 ha, depending on the size of the family. *Jhum* agriculture is rainfed and subsistence farming is the norm. The farmers return to a site after 5-10 years (Ramakrishnan 1992). The *jhum* fields may lie as far as 1.5 to 2 km from the village and are surrounded either by degraded *jhum* fallows, bamboo forests, older secondary forests or by patches of the above forest types. There may be small patches of primary forests nearby, mainly along the streams.

METHODS

The Forest Department of Meghalaya receives complaints of elephant depredation cases and files these reports. All the data (N = 23,755 cases), which are computerised for the years 1984-1993, were used to quantify elephant depredation cases that occurred in Meghalaya in general and Garo Hills in particular during this period. Each record contained the name of the village, the farmer, the crops raided and the compensation claimed/estimated. Besides, elephant post mortem reports and ivory records, collected from dead elephants in the field or seized from poachers, were obtained from the Wildlife Division Offices of the three districts. To get a quantitative measure of the economic losses due to crop raiding and to evaluate the peoples' attitudes, an intensive survey of 18 affected villages in West Garo Hills was conducted in August 1995. The villages (about 2% of the total villages in the elephant range in this district) were chosen randomly. The sub-divisional Government Officer in-charge of the division who was responsible for paying compensation told us that these 18 villages were representative of the villages in the area.

To quantify crop damage, costs were calculated by approximating the field damaged to the nearest geometrical shape (e.g. rectangle or square) and taking relevant measurements to calculate the area of damage. Five to twenty-five 1 sq. m quadrats were laid, depending on the area damaged (i.e. 5 size classes <500 sq. m, 500-1000 sq. m, 1000-1500 sq. m, 1500-2000 sq. m, >2000 sq. m), to determine the percentage of clumps (e.g. paddy, since it is planted in clumps) or plants (e.g. maize) damaged per unit quadrat area. This was extrapolated for the damaged area. Yield per hectare for crops like paddy, cotton and ginger were obtained from the local agriculture office to calculate the cost of damage. Cost of production (i.e. number of man hours spent growing and guarding the crops) could not be calculated and therefore costs of damage due to raiding are underestimates for crops. For houses, huts, and arecanut plantations, the initial establishment costs and the number of man days spent in constructing the hut, house or raising the plantation were ascertained to arrive at the actual cost of damage. Wherever possible, the identity of the marauding elephants was established by locating tracks and enquiring with the villagers who kept watch on their fields from hides built on trees.

The number of families in the villages ranged from 13 to

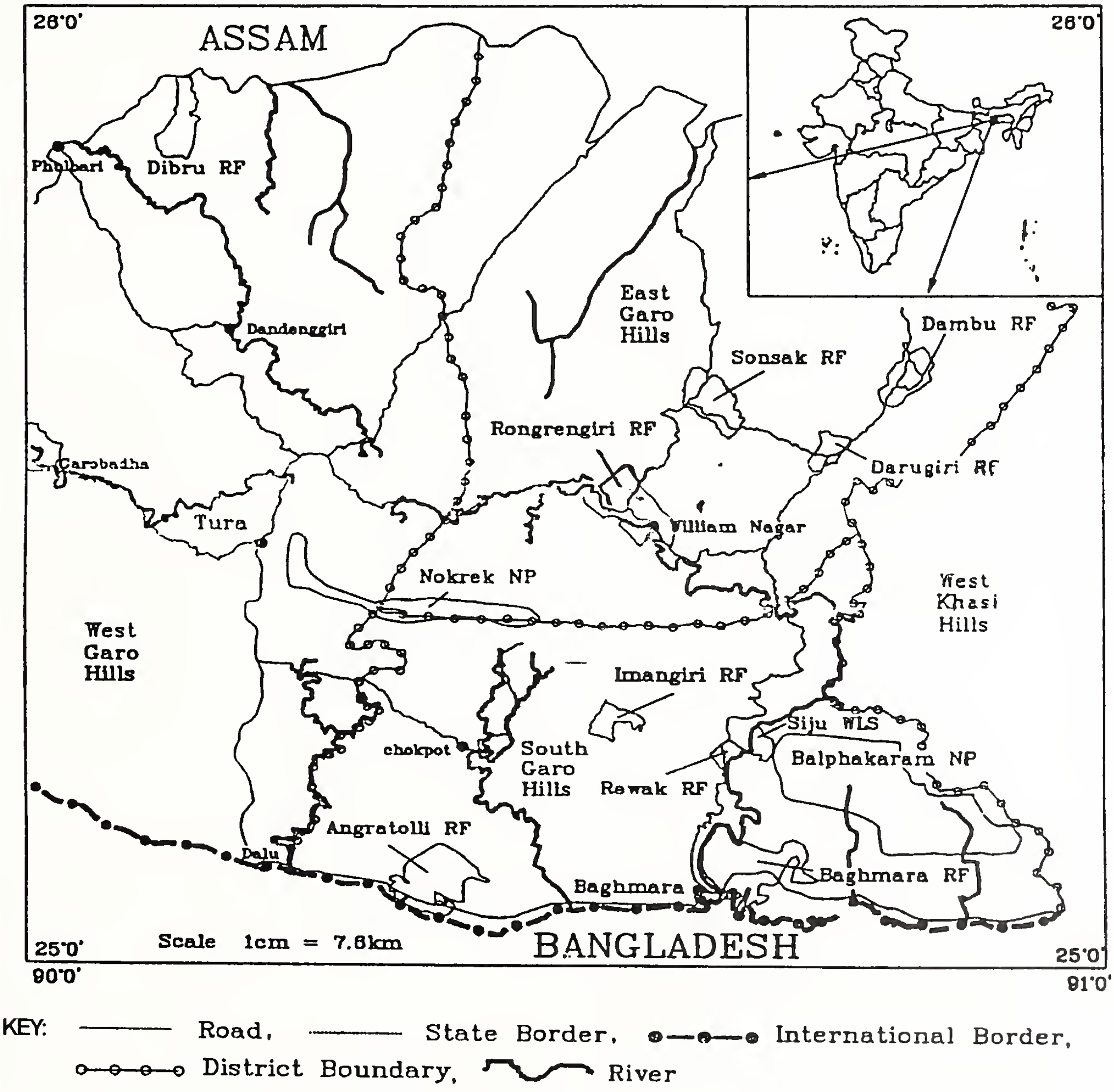
90 (mean = 38 and S.D. = 21, n = 18). As village activities are coordinated at the community level, we found it appropriate to conduct an informal interview based on a questionnaire with the village headman, or in his absence, a village elder, about their opinion on the elephant-human conflict. Questions were asked about land-use patterns (e.g. are they shifting cultivators or permanent cultivators?), compensation scheme (e.g. Does the Government pay compensation in time and are they satisfied?), preventive measures etc. Hereafter, the term “respondents” will be used for the village headman/elder. It was not possible to get responses from other villagers due to the social set up. Forest cover maps of the Forest Survey of India (1:2,50,000), based on satellite imagery, were digitised on Unix based GIS software GRASS 4.0 to quantify the area of the dense forest (>40% canopy cover) patches in and around the villages surveyed.

RESULTS

Crop raiding and property losses

The Garo Hills are an area of high elephant and human density (Table 1). Between 1985 and 1993, Garo Hills accounted for more than 86% of the depredation cases (Table 1) for which the Government of Meghalaya paid compensation. Crop damage was the main form of elephant-human conflict, and *c.* 95% of the total cases filed to date record damage to crops and households.

To determine the spatial distribution of the conflict within Garo Hills, we analysed the number of depredation cases filed between 1993 and 1995. West Garo Hills district which has the highest human density is a seriously affected region in the area (Fig. 1), accounting for 83% of the total cases (Table 2). The risk of being raided by elephants in West Garo Hills was higher than in other districts (Table 2). Most cases of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KEY:
Road,
State Border,
International Border,
District Boundary,
River

Fig. 1: Map of Garo hills showing Reserve Forests (RF), districts, roads, rivers and important towns

Table 1: Estimated population of elephants, approximate human population, geographical area, estimated elephant habitat and elephant depredations in the three hill ranges of Meghalaya

	Hill range		
	Garo	Khasi	Jaintia
Geographical area (sq. km)	8,167	10,443	3,819
Rural human population (No. /sq. km)	602,936 (74)	630,138 (60)	198,473 (52)
Elephant habitat in sq. km	3,605	2,913	925
Elephant population	1,460	742	20
No. of depredation cases (1984-93)	20,576	3,082	97
Percentage of cases	86.6	13	0.4

Source of information: Anon (1992, 1994), Williams & Johnsingh (1996), Tayeng (1981)

Table 2: Number of crop depredations by elephants, approximate number of families, human density, estimated elephant habitat, crude elephant densities in the Garo Hills between 1993-95

	Districts		
	South Garo	East Garo	West Garo
Crop depredations	780	282	5147
Human families	7957	5150	21,843
Human density (No. /sq. km)	22.9	36.4	106.7
Elephant habitat (sq. km)	1805	735	1065
Crude elephant densities (No. /sq. km)	0.51	0.50	0.16
Crop depredations / 100 families / year	4.90	2.73	11.78

depredations in West Garo Hills district occurred between June and December, with high peaks in July and August, and a lower peak in November (Fig. 2). These peaks coincided with the ripening of paddy in July and August, and availability of cotton flower buds in November.

Thirty-eight reported elephant depredation cases were investigated, out of which 28 were found to be authentic and 78% of the authentic cases were of crop raiding. The area damaged per case ranged from about 50 to 5,470 sq. m (Mean = 731.20 and S.D.= 1341.49, n = 18). Raiding was mainly for paddy (41%) and ginger (41%). Other plants damaged were cotton (9%), tapioca, maize and pineapple. Paddy, maize and tapioca were the plants eaten while ginger, cotton, tapioca and pineapple were destroyed due to trampling. Elephants also damaged arecanut trees by pushing them down. Out of 21 cases, where the raiders could be identified by following and sizing up footprints, 90% were by female groups with calves. Huts in the *jhum* fields were often destroyed during raids. During July and August 1995, nine *jhum* huts and a house were destroyed in the 18 sample villages. The estimated cost of damage per case ranged from Rs. 400/- to Rs. 5,288/- (US $ 11.7 to 154.6) [mean = Rs. 878.6 (US $ 25.7), S.D. = Rs. 1,417.7 (US $ 41), n = 29]. There is severe restriction on the movements of villagers once the elephants come into the vicinity of their villages.

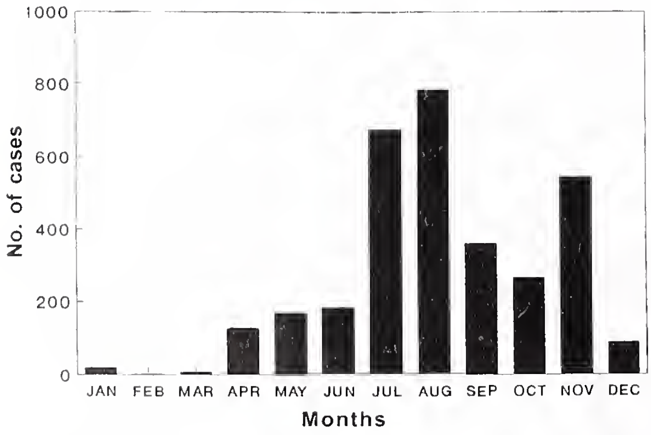

Fig. 2: Crop raiding cases registered in West Garo Hills district in 1990-1991

Elephant related human deaths and injuries

Seventy-four percent (n=65) of all deaths and 90% (n=62) of all injuries caused by elephants in Meghalaya between 1984-1995 were recorded in the Garo Hills. West Garo Hills consistently recorded the maximum number of elephant related injuries and deaths (Table 3). However, the risk of death or injury was higher in the South and East Garo Hills than in the West Garo Hills (Table 3). Deaths or injuries were caused while protecting crops, or during chance encounters with elephants on forest trails, or when some bulls turned rogues and trampled people in their huts at night.

Table 3: Human deaths and injuries caused by elephants in the three districts of Garo Hills between 1984 and 1995

	Districts		
	South Garo	East Garo	West Garo
Deaths / injuries	13[a]	28	74
Approximate human population in the elephant areas	41,370	26,780	113,583
Total deaths or injuries/ 1000 people/year	0.1	0.1	0.06

[a] - South Garo Hills district was created in 1992-93 by dividing West Garo Hills district and hence calculations were done only for that period

Table 4: Places where elephant related injury or death occurred

Place	Men	Women
Village area	11	5
Forest trails	19	6
Protecting crops	8	0
Total	38	11

The exact identity of the elephants responsible for deaths and injuries is not available. Where the circumstances leading to deaths and injuries caused by elephants between 1985 to 1995 could be ascertained, it was found that most occurred when elephants were encountered accidentally along forest trails (Table 4). More men were killed or injured than women irrespective of where the death occurred (Table 4).

Once an elephant is declared a *rogue*, license to shoot it is granted to anyone who is competent to do so. Even after the animal has been declared a *rogue*, efforts to get rid of it have not always been successful. Between 1985 and 1994, only 3 out of the 7 animals declared *rogues* could be killed.

Costs to elephants

As an alleviation measure for people suffering from elephant depredations, hunting licenses to shoot elephants used to be issued till 1981 (Gogoi and Choudhury 1982); between 1961 and 1981, a total of 226 elephants had been shot (Lahiri-Choudhury 1985). However, with passing of the Wildlife (Protection) Act 1972, capturing was completely banned and only a few exceptions have been made. Forty-three percent of the elephants (n=32), for whom post mortem or ivory records were available, died due to human related causes (e.g. speared or shot) between 1984 and December 1995 (Table 5).

All the villagers consider elephants as the property of the Forest Department. They were aware that shooting elephants is an offence and therefore, many of the respondents were not willing to answer the question whether they shoot at elephants that raid crops. Data shows that they do shoot (Table 5). There has been a sharp increase in the number of elephants killed in 1995 as compared to the previous years (Table 5). People in possession of ivory from elephants poached in Garo Hills have been arrested in the last two years. In August 1995, 6 pairs of tusks were seized in Tura, the most populous town in Garo Hills.

Trends of change in land use

In West Garo Hills, the respondents from 89% of the villages (n=18) surveyed said that the *jhum* cycle has been decreasing. Eighty-three percent of these villages had a *jhum* cycle of less than 10 years. Most of the respondents (94%) concurred with the view that the current level of *jhum* was unviable and were willing to try alternate methods of farming if proper guidance and support were provided.

Table 5: Reported elephant deaths from Garo Hills

Cause	1984-93	1994	1995
Unknown	14	3	2
Speared/shot	1	0	4
Poached	0	1	7
Total	15	4	13

Elephants are also present in the coal and limestone deposit rich East and South Garo Hill districts. During this study it was noticed that some of these areas were being mined for coal on a small scale to check the viability of mining. An area of 2 sq. km adjacent to the Rewak Reserve Forest (Fig. 1), a crucial elephant corridor in South Garo Hills, has been leased out by the villagers managing this area for mining limestone on a large scale. This corridor is an important passage for elephants and gaur *Bos gaurus* crossing over from the Balphakaram National Park in South Garo Hills district to the Angratolli Reserve Forest (RF) and Nokrek National Park area (Fig. 1) and back (Williams and Johnsingh 1997b). According to the Forest Department census conducted in 1993, this corridor connects a population of about 600 elephants on the left bank of River Simsang to about 250 elephants in the Nokrek NP-Angratolli RF area (Fig. 1). A cement factory ancillary to the limestone quarry and a housing settlement for the factory workers has also been proposed in and around this corridor area. The use of the corridor by elephants would then not be possible and the gene flow would stop if the above proposal is implemented (Williams and Johnsingh 1997b). This could result in the elephants trying to cross through alternate routes, which are heavily populated, resulting in increased incidents of elephant-human conflict.

Mitigation measures

Compensation: A total of Rs. 12,130,805 (US $ 391,300) was paid as compensation for elephant depredations on crop and property in Meghalaya between 1985 and 1993. When a compensation claim is filed, the Forest Department staff is required to inspect and assess the damage. Due to shortage of manpower and logistical problems, the process is time consuming. The claims for the year 1993 were yet to be settled in 1995. If a person was killed outside the land controlled by the Forest Department, compensation amounting to Rs. 10,000 (US $ 330) was paid. Various amounts were paid depending on the severity of the injuries. A total of Rs. 5,96,400 (US $ 19,200) was paid as compensation for the loss of lives and injuries between 1984-85 and 1992-93. No compensation was paid in cases when the death or injury occurred inside Forest Department controlled forests.

Of the 18 villages surveyed, only 15 had received compensation for elephant depredation between 1984 and 1993 at least once. The respondents in all the villages (n=18) were unhappy with the compensation scheme. The scheme is also open to abuse as 26% of the reported depredation cases (n=38) checked were found to be false. Only one out of the fifteen villages, where compensation had been paid earlier, wanted continuance of the scheme as a mitigation measure in its present form.

Preventive measures: The methods used to ward off elephant raids were similar in all parts of Garo Hills. Shouting, beating tins, and brandishing burning torches were commonly used. Villagers said firing gun shots over the heads of the elephants only resulted in their retreating for a short distance, or in some cases had no effect.

Eighty-nine percent of the respondents said that the number of elephants has increased noticeably. When asked for a reason for the apparent increase, 44% of the respondents blamed stopping of elephant capture. Till 1981-82, the Forest Department of Meghalaya used to capture elephants from different elephant areas of the state. A total of 1,298 elephants were captured in Meghalaya between 1960 and 1981 (Lahiri-Choudhury 1985) by the traditional *mela shikar* method.

Asked for their opinion on mitigating elephant-human conflict, 28% of the respondents wanted elephants to be removed from their area. Other suggestions were paying compensation (16%) and electric fencing of their land by the Government (16%). The rest were unsure and wanted the Forest Department to take action to reduce crop depredations. All the respondents were eager to try any method that might reduce their losses.

DISCUSSION

Elephant-human conflict is fast emerging as an important issue in the Garo Hills, especially in the West Garo Hills district. Most of the conflict is due to crop raiding. An average of 11.74% families are affected in West Garo Hills every year (Table 2). The estimated total cost of damage caused by elephants for the 28 authentic cases was Rs. 24,600 (US $ 683) or Rs. 880 (US $ 24) per case. This means that the affected families lose about 8% of their annual income, which is about Rs. 11,000 (US $ 305). The damage caused is comparable to the results obtained by Sukumar (1991) who reported that the cost of elephant depredations was US $ 21 per family, and the total damage caused by 200 to 250 elephants amounted to US $ 18,960. In another study on crop raiding patterns in central India, the total damage caused to 10 large villages by about 65 elephants was estimated to be around US $ 5,000 (Datye and Bhagwat 1995). In West Garo Hills, on an average, 2000 cases are reported every year. If 75% of these cases are true, the total damage caused by a population of 160 elephants is around Rs. 13,17,000 (US $ 36,000) per annum.

Several reasons have been given to explain crop raiding (McKay 1973; Olivier 1978; Sukumar and Gadgil 1988; Santiapillai and Widodo 1993). Fields that have highly nutritious crop would attract elephants living in patchy and degraded environments. The West Garo Hills have various sizes of secondary and primary forests, in various stages of degradation, scattered with *jhum* fields. A few valleys have permanent cultivation. Patches of forest, classified as dense forest (see methods), in and around the surveyed villages, ranged from 1.12-16.26 sq. km (mean = 5.62 sq. km). The smallest known home range of an Asian elephant bull is 32 sq. km (Olivier 1978) and that of a female group is 34 sq. km (Joshua and Johnsingh 1995), and it is unrealistic to expect the small patches in West Garo Hills to provide elephants all their ecological requirements. Therefore, they are forced to move from one patch to another. During such ranging the newly created *jhum* fields in the vicinity with extremely palatable and nutritious crops are raided. This was noticed in another study on elephant-human conflict in southern India (Nath and Sukumar 1998). Female groups with calves and juveniles tend to avoid areas with high risks, like being fired at or chased with fire torches. The fact that a number of raids on *jhum* fields were carried out by groups indicates that the risks here are possibly low.

For preventive measures, like electric fencing or trenching, to be effective, it is important to understand which areas are raided and why certain crop fields are raided more than others. Crop fields near traditional routes may be raided more often than other fields. Therefore, a study using radio telemetry to understand how elephants find resources to survive in an environment that can change dramatically every one or two years due to *jhum*, has to be taken up immediately. It may be possible to predict elephant movements (Ekobo 1997) and therefore vulnerability of the various crop fields to raiding by elephants. Electric fencing may work in areas of permanent settled agriculture as in Zimbabwe (Taylor 1993), but not in areas of shifting agriculture. Therefore, the management should work to wean away the tribals from *jhum*.

In Meghalaya, the human population has undergone an eleven-fold increase between 1881 and 1991 (Tayeng 1981; Anon 1992). Ramakrishnan (1992) states that a *jhum* cycle of at least 10 years is considered necessary for the *jhum* to be viable economically and energetically. This can happen only when the human population density remains low. The current high human densities in West Garo Hills (Table 2) have already shortened the *jhum* cycle to less than 10 years. If the human population continues to grow at the current rate (*c.* 3.2% per year), elephant-human conflict is bound to increase. Elephant conservation may finally depend on how effectively we curb the growth of the human population and its dependence on *jhum* agriculture, which lies outside the scope of wildlife management agencies. An integrated approach, involving the local administration and non-governmental organisations

(NGOs) is required for conservation efforts to be successful. These agencies should introduce alternate sources of livelihood like piggery, small pond fisheries and bee keeping, and family planning education. Otherwise, as Hoare (1998) predicts, the threshold of land cover transformation will be reached, resulting in the disappearance of the elephants from their natural habitat.

Many lives are lost while protecting crops or property from elephants. More men are killed than women, as men encounter elephants more often in their day-to-day life. This was also observed in other elephant-human conflict areas in south and central India (Sukumar 1991; Datye and Bhagwat 1995). When a bull turns into a rogue, killing and damage to property rapidly increases in its range. A general fear psychosis builds up among the villagers when a rogue wanders around in the vicinity of the village. Due to logistical and bureaucratic delays, it takes time for a rogue to be identified, declared a rogue and shot. This results in further loss of lives and property. Decentralisation of this process with the involvement of the local Divisional Forest Officer may help to speed up the process of eliminating the rogue.

Compensation raises the tolerance threshold of affected people for species like elephants that can cause huge economic damage (Tchamba 1995, 1996). The compensation scheme was put into practice without proper planning and logistical support. The forest department lacks adequate staff to verify the claims. Therefore, some people are misusing the scheme by filing false claims. The scheme is also tied up in bureaucratic delays, and payment for verified claims is delayed for years. It is not surprising, therefore, that there is widespread dissatisfaction among the villagers, both with the amounts paid and the delays in the scheme. Nevertheless, a limited investigation showed that a number of genuine compensation claims (approx. 74% of the cases) are filed every year, illustrating the ineffectiveness of the deterrence methods in use. There is no one fool-proof method of preventing elephant depredations (Thouless and Sakwa 1995) and the best option may be to try different methods. Elephant capture can help to control the problem and it should be resorted to in places with severe crop depredations.

It is likely that in an industrially backward state like Meghalaya with low per capita many more areas will be taken up for mining limestone and coal. A few of these areas constitute some of the best elephant habitats or they lie in crucial corridor areas. Elephant-human conflict therefore is bound to increase as economic interests dictate the exploitation of these areas. It is still possible for the government to acquire large tracts of land as the price of land (*c.* US $ 7000/sq. km) is relatively low. Therefore, funds will have to be raised to acquire crucial areas like corridors or primary elephant habitat which lie in these mineral rich zones.

Until recently, very few cases of elephants killed by humans were reported. But the spurt in elephant deaths, between January and December 1995, due to humans, and the ivory seizures indicated that the situation could worsen if not tackled immediately. Till 1995, most of the deaths were due to gunshot or spear wounds received while crop raiding. However, since 1995 most of the elephants killed have been tuskers, and ivory seizures also indicate increase in poaching. Menon *et al.* (1997) reported that there exists a sizeable underground trade in elephant meat and a few seizures of processed elephant meat points to the worrying conclusion that even a female may not be spared if she gets out of control. One of the main problems in Garo Hills is the lack of manpower and money to carry out effective conservation of elephants on community lands. It may be a cheaper and more beneficial long term management solution to concentrate efforts in closing down the trade in elephant meat.

The problem of elephant-human conflict is assuming serious proportions in Garo Hills. Most people express dissatisfaction over the efforts taken by the Government to solve the problem. For Meghalaya, a modest goal of reducing elephant depredation by 20% to 30% in the next three to four years would do much to convince the people about the efforts taken by the Government to control the problem (Williams and Johnsingh 1997a, b, c). The Garo Hills elephant population is one of the two populations in northeast India, which seem to have the minimum numbers to be viable in the long run. The elephants in northeast India have been genetically isolated from the other elephant populations in India for a long time. Therefore, from a conservation point of view, they are most important. The lessons we learn in Meghalaya, in the process of reducing costs to both elephants and humans, are going to prove invaluable for conservation in India and elsewhere in Southeast Asia and Africa where the land use patterns are similar.

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KEMMANGUNDI REVISITED: NOTES ON BIRDS OBSERVED AT THE BABABUDAN HILLS, KARNATAKA, SOUTH INDIA[1]

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Kemmangundi, a popular hill station in the central Western Ghats, was visited for seven days in May 2002 to survey the birdlife in the surrounding *shola*-grassland mosaic. Several threatened species endemic to the Western Ghats, such as *Brachypteryx major, Schoenicola platyura* and *Columba elphinstonii* were among the 97 species of birds recorded. The significance of several observations lies in the fact that the birdlife of the central Western Ghats has not been thoroughly investigated except for a few studies conducted intermittently over the past seventy years, a fact that needs to be urgently addressed.

Key words: Western Ghats, Kemmangundi, *Brachypteryx major, Schoenicola platyura*

The present note is a discussion on birds observed by me at the Bababudan hills on a visit from May 21-27, 2002, and a comparison with birds noted and collected by Sálim Ali during his stay at Kemmangundi from January 19-24, 1940 (Ali 1942a-c, 1943a, b). Comparisons of resident birds recorded in the two surveys, with emphasis on Western Ghats endemics, reveal that a few species have retained or even improved their status since the 1940s, while a few others, especially grassland dependent species, have become rare. The avifauna of the central Western Ghats in Karnataka has not been well documented except in Kodagu (Coorg) (Betts 1929a, b; Betts 1951). Previous records of birds from Kemmangundi, like the White-bellied Shortwing *Brachypteryx major* and Nilgiri Flycatcher *Eumyias albicaudata* were the only records of the species north of Kodagu for long (Ali 1942b). Records of the Jerdon's Baza *Aviceda jerdoni*, Mountain Hawk-Eagle *Spizaetus nipalensis*, Ceylon Frogmouth *Batrachostomus moniliger*, Grass Owl *Tyto capensis*, Broad-tailed Grass-Warbler *Schoenicola platyura* from the Karnataka Western Ghats have been few. This paper clarifies the status of these birds in the Bababudan Hills.

The Bababudan Hills are a horse-shoe shaped range of high ridges located in the Chikmagalur district of Karnataka between 13° 23'-13° 35' N and 75° 37'-75° 52' E. The hills, an eastern off-shoot of the Western Ghats, run with a valley in the centre of the horse-shoe known as the Jagara valley (600 m) facing northwest; and have an average height of 1,400 m, reaching a maximum of 1,925 m (6,317 ft) at Mulaianagiri, the highest peak in Karnataka. The ridges are narrow and steep, with cascading cliffs on the outer end of the horse-shoe and interrupted by undulating hills on the inner side, covered by grassland on the slopes and luxuriant sholas, wet temperate montane evergreen forests, in the ravines between hills (Saldanha 1984).

Kemmangundi (13° 33' N, 75° 45' E) is a small, pleasant hill station established in 1932 by the Maharaja of Mysore, Krishanarajendra Wodeyar IV on the northeastern end of the hill range. At 1,434 m (4,702 ft), it is located by an abandoned open-cast iron mine. Kemmangundi in Kannada translates as 'red soil pit' (*Kemmannu* = red soil, *gundi* = pit), referring to the soil colour in the mining pit, as well as the surroundings. Mining for iron ore continues on a small scale on nearby hillsides. Large, dense sholas surround the place and these, along with a few neighbouring ones, are the more intact ones left on the range. Kemmangundi served as a base camp for Sálim Ali in 1940, when he visited the Bababudan hills while surveying the birds of the erstwhile princely Mysore State (Ali 1942a).

The Bhadra Tiger Reserve covers 451.7 sq. km of predominantly tropical moist mixed deciduous forest, with smaller areas under tropical dry deciduous, semi-evergreen forests mostly in the Jagara valley, montane wet temperate evergreen forests or sholas and montane grasslands in parts of the hill range. A few remnant patches of lowland evergreen forest occur on the southeastern fringes of the reserve in the Jagara valley.

METHODS

Observations were made along selected paths through *sholas* and grasslands at Kemmangundi, the adjacent Bhadra Tiger Reserve and remnants of lowland evergreen forest in the Jagara valley. The paths were selected so as to cover both pure *shola* stretches and grassland, and the interface between the two. Monitoring of paths was done in the morning between 0600 and 0900 hrs and in the evenings between 1630 and 1830 hrs. Observations were conducted intermittently throughout the day from May 22-24, and for the whole day on May 21 and 25-27. Night transect was conducted twice for nocturnal birds. Elevations between 800 m and 1,700 m were covered.

OBSERVATIONS

A total of 97 species of birds were observed in seven days. Twelve of the sixteen species found only in the Western Ghats Endemic Bird Area were recorded (Jhunjhunwala *et al.* 2001). Significant sightings include those of the Jerdon's Baza *Aviceda jerdoni*, Mountain Hawk-Eagle *Spizaetus nipalensis*, Grass Owl *Tyto capensis*, Ceylon Frogmouth *Batrachostomus moniliger*, Blue-eared Kingfisher *Alcedo meninting*, Wynaad Laughingthrush *Garrulax delesserti*, Grey-breasted Laughingthrush *Garrulax jerdoni*, Broad-tailed Grass-Warbler *Schoenicola platyura*, all new records for the Bababudans and for the Bhadra Wildlife Sanctuary.

Confirmed breeding of the Nilgiri Wood-Pigeon *Columba elphinstonii*, Speckled Piculet *Picumnus innominatus*, Red-whiskered Bulbul *Pycnonotus jocosus*, Yellow-browed Bulbul *Iole indica*, Indian Scimitar-Babbler *Pomatorhinus horsfieldii*, Malabar Whistling-Thrush *Myiophonus horsfieldii*, Eurasian Blackbird *Turdus merula*, Nilgiri Flycatcher *Eumyias albicaudata*, White-bellied Blue-Flycatcher *Cyornis pallipes* and Brown Rock Pipit *Anthus similis* was observed.

An asterisk (*) after the common name indicates a Western Ghats endemic. SA refers to Sálim Ali. Status of threatened and near threatened species follows BirdLife International (2001). Botanical identification and nomenclature follows Gamble (1956) and Saldanha (1984, 1996). The standard common and scientific names follow Manakadan and Pittie (2001)

Globally Threatened Species

Indian White-backed Vulture (*Gyps benghalensis*): Critical. Repeated sightings of single birds soaring near Kemmangundi. Not recorded by SA.

Long-billed Vulture (*Gyps indicus*): Critical. One sighting of ten birds, all adults, soaring with thermals on May 22 near Kemmangundi. Not recorded by SA.

Nilgiri Wood-Pigeon* (*Columba elphinstonii*): Vulnerable. Common in *sholas* and partial to *Syzigium wightianum* and *S. operculatum* trees that were fruiting in abundance everywhere (see Appendix 1). Individuals were observed indulging in acrobatics like Green-Pigeons to get to the drupes of their choice, usually the ripest one in the bunch, several seen in action – clinging upside down on branches and balancing with outspread wings and tail. Very vocal; one of the commonly uttered calls was a fast '*ku-kuu*', immediately ending in an abrupt '*ku*'. Variations of the same, with varying numbers of the first note also heard occasionally. Another call noted was a deep 'wah-kwoo-woo'. These were in addition to the usual langur-like deep 'who's. The bird was observed and collected by SA at Kemmangundi and noted to be "fairly common" (Ali 1943a).

A nest was observed on May 23 in a shallow fork on a thickly foliaged *Apodytes dimidiata* tree *c.* 8 m from the ground, along a stream in the Shankara *shola*. The nest was a clumsy platform of twigs and had a single white egg under incubation.

White-bellied Shortwing* (*Brachypteryx major*): Vulnerable. The race *major* is resident, fairly frequent only in *sholas* above *c.* 1,300 m. Observed after a period of sixty years at Kemmangundi. Observers after Ali (1942b), if any, probably missed it due to its retiring habits, or because they did not spend enough time looking for it. Easily seen in twilight, with the aid of a torch or jeep headlights, along roads when they come out of the *sholas* to feed. In flight noisy for its size, perhaps because of its small wings and fairly rapid wing beat. Easily seen in ravines, in leaf litter under thickets along streams, and near bridges over streams in the sholas. It can also be observed at the Kudremukh National Park, Kumaraparvata Peak in the Pushpagiri Wildlife Sanctuary, Brahmagiri hills under the Brahmagiri Wildlife Sanctuary, both in Kodagu district; and the Kodachadri Peak in the Mookambika Wildlife Sanctuary across Udupi and Shimoga districts, which is perhaps the northern limit for the species (*pers. obs.*). Specimens collected by SA from Kemmangundi (Ali 1942b) and noted as "Frequent, but not common in accustomed facies." Birds can be seen even in the most isolated, small patches of *shola*, one of which was hardly 3-4.5 m at *c.* 1,600 m!

Broad-tailed Grass-Warbler* (*Schoenicola platyura*): A new record for the Bababudans and a significant one for a Vulnerable species (BirdLife International 2001). Encountered thrice in the span of a week, twice above Kemmangundi on May 23 and 24 in *Chrysopogon-Andropogon* grassland and *Strobilanthes* thickets and once at Mulaianagiri on May 26 in grassland. The bird observed at Kemmangundi early (0630 hrs) on May 24 was calling out loud from the top of a grass clump, with its head facing the sky, a sweet 'pseit' continuously seven to eight times, ending in '*chrr*', '*chut*' or loud '*chit*'. The other birds were seen when accidentally flushed and then followed in the grassland for quite a distance; a difficult species to observe due to its skulking habits. Not noted by SA.

Globally Near-Threatened Species

Malabar Pied Hornbill (*Anthracoceros coronatus*): One sighting of a flock of five on May 27, at the foothills *c.* 700 m, feeding on a large fruiting *Ficus arnottiana* tree in a coffee plantation. This species, along with the next, are probably rare in the Bhadra Tiger Reserve and declining throughout its range. Not recorded by SA.

Great Pied Hornbill (*Buceros bicornis*): One spectacular and memorable sighting of seven birds swooping down the Hebbe waterfalls (9 km from Kemmangundi) in succession, plummeting from *c.* 121 m (400 ft) to a large fruiting *Ficus beddomei* in tall evergreen riparian forest on May 24. Not recorded by SA.

Grey-breasted Laughingthrush* (*Garrulax jerdoni*): A new record for the Bababudans and for the central Karnataka Western Ghats. This record bridges the distribution gap between Goa (Rane 1984) and Coorg (Ali and Ripley 1987). Uncommon in three *sholas*, all large and contiguous with each other, status elsewhere unknown; found only above 1,100 m. Bands of up to eight birds noted frequenting clumps of fruiting *Rubus fockei*; one flock of four seen on May 24 at 900 m on the roadside beside a coffee estate, feeding on fruits of the Mulberry, *Morus alba*. I have also observed the species at the Kudremukh National Park in early March 2002.

Nilgiri Flycatcher* (*Eumyias albicaudata*): Fairly common resident in *sholas* above 1,300 m. Breeding noted at Kemmangundi, four nests with nearly fledged chicks and one with three eggs under incubation were observed in the Shanti waterfalls *shola*. Nests were of moss, all placed in tree fissures or cavities 3-6 m from the ground. Fledged chicks that have left the nest were observed, some still being fed by the parents. Song given by Kazmierczak (2000) as "*chee-chew chewy chi-chwee chwee choo chi-choo chee*" is slightly different for all birds heard in the Bababudans; the song here was almost identical in the first seven notes but was longer and had a few extra notes in the end "*chee-chew chewy chi-chwee chwee-chee, choe chi-choe choe chee choe-chee*" and a refrain, "*chee-chew chewy choe-chi choe-chi*" that was repeated two to three times after the initial song, with a couple of '*chee*'s one way or another. A threatened bird in these hills with a very limited range in *shola* forest above 1,300 m. A few large *sholas* around Kemmangundi and in the Bhadra Tiger Reserve are the only strongholds left relatively intact. It was not seen in plantations, whereas it is commonly seen in plantations in the Nilgiris (Ashfaq Ahmed Zarri, *pers. comm.*). Collected and noted by SA at Kemmangundi (Ali 1942b).

Notes on Selected Species

Jerdon's Baza (*Aviceda jerdoni*): Four birds were observed on May 24, in a large shola located in the Bhadra Tiger Reserve, beside a stream at *c.* 1,000 m and 4 km from Kemmangundi on the road to Chikmagalur. The birds, all adults, were readily identified by their gregarious habit; a thin, white-tipped, clear upright crest; rufous head streaked black, more so on the nape; a clear, thin black mesial stripe; underparts clearly and broadly barred rufous; tail barred black with terminal white tip. In flight, it was observed to be different from the Crested Goshawk (*Accipiter trivirgatus*), which has incidentally also been recorded, in having distinct black tips to the primaries, which the Goshawk lacks. The Mountain Hawk-Eagle (*Spizaetus nipalensis*), another bird with which the Baza could be confused is much larger and with a crest not pointing upwards in normal situations. Also, the underwing coverts are uniformly rufous-buff in flight, whereas in the Baza it is thinly barred rufous. The birds were located on successive days, May 25 and 26, in the same *shola*, but a few hundred metres downstream of the earlier sighting. One bird was observed consuming a small, dark rufous-brown squirrel. No calls heard.

The Jerdon's Baza is a rare resident in southwest India, although more common in parts of northeast India, preferring foothills with evergreen forest between *c.* 12° N in western Karnataka, and Kerala (Ali and Ripley 1987). There are very few actual records of the bird from the Western Ghats, with Kazmierczak (2000) able to trace only four from the Western Ghats, and one from Karnataka. Recent records of the bird have mostly been from Kerala. This record, after a long time in Karnataka, is significant, as extensive tracts of ecologically suitable evergreen forest in the Western Ghats of Karnataka remain under-surveyed, or even unsurveyed, for birds. The bird could thus be expected to occur in evergreen forests of the Shiradi, Charmadi and Agumbe Ghats of Dakshina Kannada, Hassan, Shimoga districts; and in the Uttara Kannada district. Not recorded by SA in his Mysore survey.

Short-toed Snake-Eagle (*Circaetus gallicus*): A single sighting of a soaring adult on May 22 above Kemmangundi *c.* 1,500 m. The "cumbrous and ungainly hovering" against winds (Ali 1996) of 60-70 kmph, was noted over grassland close to the 'Z-point', the extreme eastern end of the hill range and about 1.5 km from Kemmangundi. The bird is uncommon at this altitude in south India and probably rose with thermals. Not recorded by SA.

Crested Goshawk (*Accipiter trivirgatus*): One bird observed from above, gliding over the Shankara *shola* at Kemmangundi on May 21 and alighting on a *Schefflera rostrata* tree. Not recorded by SA.

Rufous-bellied Eagle (*Hieraaetus kienerii*): One bird seen perched at a 'vantage point', on a fruiting *Syzigium operculatum* tree overlooking the large Shankara *shola*, everyday between May 21 and 24. Not recorded by SA but noted by one observer earlier (Shyamal 1993).

Mountain Hawk-Eagle (*Spizaetus nipalensis*): Rare resident? One bird seen in flight over the Shankara *shola* on May 22 and 23. It was first seen alighting on a *Eucalyptus* tree close to the tourist complex at Kemmangundi. Not noted by SA.

Mountain Imperial-Pigeon (*Ducula badia*): A single flock of six birds feeding on *Ficus glomerata* figs near the Potato Research Station of the Horticulture Department at Kemmangundi on May 22. Not noted by SA.

Grass Owl (*Tyto capensis*): Another first record for the Bababudans, and a northern extension of the bird's range in the Western Ghats; being previously known up to the Brahmagiris in Kodagu (Coorg) (Ali and Ripley 1987). Two birds flushed from a depression in tall, dry *Chrysopogon* grassland bordered by *Strobilanthes* clumps on May 24 in the Bhadra Tiger Reserve. The birds soon settled a couple of hundred metres away in the grassland and were wary of approach, either running away or flying a short distance before settling in the grass.

I have also observed a lone bird at night (2030 hrs) near the Kerekatte forest rest house in the Kudremukh National Park in early March 2002, feeding on a rodent.

Brown Wood-Owl (*Strix leptogrammica*): One freshly dead bird was found at Kemmangundi on May 24. Measurements: Wing 325 mm, Bill (from skull) 45 mm, Tarsus 56 mm, Tail 195 mm. Plumage appeared much worn with no signs of moult either in wing or tail. Cause of death not apparent, probably natural. Also heard twice during night transect through Shankara *shola*. Not noted by SA.

Ceylon Frogmouth (*Batrachostomus moniliger*): A first record from the Bhadra Tiger Reserve on the Bababudans, and a significant one as it is from the intervening country between the northern recorded limits — Radhanagari Wildlife Sanctuary in Kolhapur district of Maharashtra (Giri 2001), Uttara Kannada district (North Kanara) in Karnataka (Borges 1986, Daniels 1984) and southern limits in Tamil Nadu - Kerala (Ali and Ripley 1987; Gaston and Zacharias 1996; Kannan 1993; Sugathan 1981). Three birds, two males and a female, were noted roosting 5 m from the ground, on bamboo thickets by a stream in thick shola on May 25. They were encountered by chance when following a Grey-headed Bulbul, *Pycnonotus priocephalus* through the bamboo. The birds were inactive, but became alert when the bamboo was accidentally disturbed on close approach. They were noted in the same spot again on May 26 and 27.

Blue-eared Kingfisher (*Alcedo meninting*): Two sightings of single birds of this uncommon species; one by a stream in the Shankara *shola* at *c.* 1,000 m and the other by a large pool of water at the foot of the 137 m (450 feet) high Hebbe falls located in the midst of evergreen forest and a coffee estate. Not noted by SA.

Great Black Woodpecker (*Dryocopus javensis*): Uncommon. A single sighting of an individual drumming away high on a tall *Dipterocarpus* tree in riparian evergreen forest on May 24. A female collected by SA from the Jagara Valley (Ali 1942c). This species is common in the mature moist deciduous forests of the Bhadra Tiger Reserve, which is a haven for woodpeckers.

Indian Pitta (*Pitta brachyura*): Status equivocal. A single sighting of a bird calling on a tree *c.* 10 m above ground, persisting for around twenty minutes at 0630 hrs on May 23 near the guest house at Kemmangundi. Calls heard repeatedly after this sighting. Baker and Inglis (1930) on the breeding season of the Pitta state, "It is said to breed during the rains in Kanara, but I have not had the good fortune to find a nest."

Malabar Crested Lark (*Galerida malabarica*): Rare. Two sightings on hill summits, one at Kemmangundi of four birds (*c.* 1,500 m) and the other at Mulaianagiri (*c.* 1,900 m) of a single bird. Ali (1942c) notes "Fairly common. Met with small parties and loose scattered flocks of up to 30 birds or so, on grass-covered hill slopes with outcrops of sheet rock." A male was collected by SA at above Kemmangundi (Ali 1942c). This bird was not seen, despite a lookout for it on the Kemmangundi-Chikmagalur road that runs 40 km, covering a major portion of the range at the tops; but it could be more common than apparent and has certainly seen a decline over the years.

Grey-headed Bulbul* (*Pycnonotus priocephalus*): Uncommon, possibly overlooked. A denizen of the deepest *sholas*, with a preference for stream-side vegetation, also bamboo in lower elevations. This species has been noted from riverine vegetation in the moist deciduous forests at Muthodi in the Bhadra Tiger Reserve but rare at that location (S. Karthikeyan *pers. comm.*, *Author's pers. obs.*). Noted by SA in the Jagara Valley (Ali 1942b).

Black-crested Bulbul (*Pycnonotus melanicterus gularis*): Uncommon in *shola* edges and disturbed areas, thickets of *Rubus fockei*, while *Lantana* is a favourite in lower elevations and coffee plantations, often in mixed flocks. Not recorded by SA.

Scaly Thrush (*Zoothera dauma*): Rare, perhaps overlooked, resident, heard more often than seen. Three sightings at Kemmangundi, deep in the Shankara *shola*. Calls heard sometimes close to road, also heard in neighbouring *sholas*. Not recorded by SA and a new record for the Bababudans. Also occurs in the Kudremukh National Park (*pers. obs.*).

Wynaad Laughingthrush* (*Garrulax delesserti*): Recorded only once on May 25 in the same *shola* as the Jerdon's Baza, a flock of around eight birds keeping to the thick undercover in a mixed party of Indian Scimitar, Indian Rufous and Black-headed Babblers, Grey-headed Flycatcher, Black-crested Bulbul, Large Wood-Shrike and Greater Golden-backed Woodpecker. Loud, discordant cackling in unison, on alarm. Not recorded by SA and a first record for the Bababudans where populations are probably small and isolated due to degradation of intervening habitats. Occurs in and around the Kudremukh National Park (*pers. obs.*; Ahmed and Bhat 2001a, b), Agumbe (Ali 1942b), around Jog Falls, Charmadi Ghat, Sampaje Ghat, Kumaraparvata mountain in the Pushpagiri Wildlife Sanctuary, Brahmagiri Wildlife Sanctuary and adjoining reserve forests and Kemphole State Forest on the Shiradi Ghat where it is particularly common.

Rufous-bellied Babbler (*Dumetia hyperythra*): Resident at Kemmangundi, restricted to gardens near the guest houses, the horticulture department rock garden, disturbed areas of thickets and undergrowth bordering plantations; never in *sholas* where it is replaced by the Black-headed Babbler, *Rhopocichla atriceps* (*pers. obs.*; Ali 1942b).

Indian Rufous Babbler* (*Turdoides subrufus*): Resident, not common but frequent in undergrowth of *Cinnamomeum*, also disturbed areas bordering *sholas*; often in small parties of three to four birds, very shy. Not noted by SA.

Golden-headed Fantail-Warbler (*Cisticola exilis*): Rare resident on grassy hilltops above Kemmangundi, at Mulaianagiri and Bababudanagiri. A few birds also observed in *Strobilanthes* thickets between *sholas* and grassland. Collected by SA from various points in grasslands and noted as common for the entire hill range (Ali 1942c).

White-bellied Blue-Flycatcher* (*Cyornis pallipes*): Common resident in *sholas*, thick evergreen forest and riverine bamboo forest from *c.* 800 m to the highest elevations, but generally less common above 1,400 m. Nest building in progress in a tree fissure *c.* 2 m from the ground in the Shankara *shola*, beside a road. Female was observed to contribute most to nest building, collecting moss from nearby branches of trees, as well as arranging the material in cup form. Otherwise seen singly in *sholas*, even disturbed areas bordering *sholas*, hawking insects from telegraph wires; also coffee estates bordering *sholas*. The male sings a sweet early morning song, on awakening: "*chi-chi-chi-chi-chi-chwai-chwai-chwai*", ending on a somewhat questioning note. SA collected the bird from Kemmangundi and noted it as "fairly common" (Ali 1942b).

Black-throated Munia (*Lonchura kelaarti*): Common resident on the lower slopes, in disturbed areas and about cultivation. Once a flock of ten at the Potato Research Station of the Horticulture Department at Kemmangundi. Also common in the lower reaches of the Bhadra Wildlife Sanctuary. A range extension for the species, not previously documented from areas north of Kodagu district (Ali and Ripley 1987), but is now known to be common but patchy all along the Western Ghats in Karnataka; in Dakshina Kannada, Uttara Kannada, Hassan, Chikmagalur, Udupi, Shimoga and Belgaum districts (*pers. obs.*; S. Karthikeyan *pers. comm.*; J.N. Prasad *pers. comm.*; Anand Prasad *pers. comm.*). Not noted by SA.

White-bellied Tree-pie* (*Dendrocitta leucogastra*): Resident, common in mixed parties in *sholas*, tall evergreen forests on lower slopes and coffee plantations with good tree cover, bordering *sholas*. Noted by SA on the Bababudans (Ali 1942a).

DISCUSSION

Sálim Ali recorded sixty-nine species of birds, including thirteen winter visitors, at the Bababudan hills in January 1940. In this survey, in May 2002, ninety-seven species of birds were observed, not including winter visitors. Forty-three species were added to the bird list of Ali (1942-43) and Shyamal (1993) {see Appendix 2}.

Threats to Endemic Bird Habitats

Sholas: *Sholas* have been denuded to a great extent in these hills, being replaced by coffee and eucalyptus plantations. The extant area under relatively intact *shola* cover lies within the Bhadra Tiger Reserve, towards the western end of the ridge. Iron mining is a threat in certain areas, with loose soil being exposed by the open cast method; erosion and landslides become inevitable during the monsoon. These *sholas* are the birthplace of the river Vedavati, one of the tributaries of the Krishna.

Shola specific species like the White-bellied Shortwing and Nilgiri Flycatcher will face the impact of the denudation of *sholas* (Maheshwaran 2001).

Grasslands: Grasslands are also imperiled, being targeted by the Forest Department for *Eucalyptus* and *Aloe* plantation programmes under the wasteland development and afforestation schemes of the Karnataka government. Mining is a greater threat to grasslands than to *sholas*, as it is primarily the hilltops that are dug out for ore. Deep fissures on the hill-side being mined reveal the importance of grass cover in holding the soil together. Grasslands in the Bhadra Tiger Reserve are particularly in danger of being planted over. Rahmani (1992) points out that grasslands are insufficiently represented in the protected areas of the Indian subcontinent, and this needs to be urgently addressed.

Species like the Grass Owl, Malabar Crested Lark, Brown Rock Pipit, Gold-headed Fantail-Warbler and Broad-tailed Grass-Warbler found only in grasslands will be severely affected (Maheshwaran 2001).

A detailed survey of the avifauna of the central Western Ghats in Karnataka has to be taken up at the earliest to update our knowledge of the birds of the Western Ghats as there have been only a handful of studies in the area (Chakravarthy and Tejasvi 1992, Daniels 1997), with ornithologists concentrating on the forests of the southern Western Ghats like the Nilgiri Plateau in Tamil Nadu and forests of Kerala. Globally threatened species like the White-bellied Shortwing and Broad-tailed Grass-Warbler need to be specially studied to assess their status, range and populations in the central Western Ghats.

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Appendix 1: Numbers of globally threatened and near-threatened species observed at Kemmangundi

Species							
Date	21.v.2002	22.v.2002	23.v.2002	24.v.2002	25.v.2002	26.v.2002	27.v.2002
*Gyps benghalensis**	1	1	-	1	-	-	1
*Gyps indicus**	-	10	-	-	-	-	-
*Brachypteryx major**	6	4	3	12	3	5	3
*Columba elphinstonii**	6	8	9	15	6	7	27
*Schoenicola platyura**	-	-	1	1	-	1	-
Anthracoceros coronatus#	-	-	-	-	-	-	5
Buceros bicornis#	-	-	-	7	-	-	-
Garrulax jerdoni#	8	8	-	4	7	8	-
Eumyias albicaudata#	8	7	5	18	10	5	4

* Globally threatened species, # Globally near-threatened species

Appendix 2: A checklist of birds of Kemmangundi $^{\alpha,\beta}$

Species	Sálim Ali	Shyamal	Thejaswi	Status
Aviceda jerdoni, Jerdon's Baza			*	R
Pernis ptilorhynchus, Oriental Honey Buzzard		*	*	C
Milvus migrans, Black Kite			*	?
Gyps benghalensis, Indian White-backed Vulture			*	R
Gyps indicus, Long-billed Vulture			*	R
Circaetus gallicus, Short-toed Snake-Eagle			*	R
Spilornis cheela, Crested Serpent Eagle	*			?
Accipiter trivirgatus, Crested Goshawk			*	UC
Accipiter virgatus, Besra Sparrowhawk			*	C
Ictinaetus malayensis, Black Eagle		*	*	C
Hieraaetus kienerii, Rufous-bellied Eagle		*	*	C
Spizaetus cirrhatus, Changeable Hawk-Eagle#			*	-
Spizaetus nipalensis, Mountain Hawk-Eagle			*	R
Falco tinnunculus, Common Kestrel		*	*	C
Falco peregrinus, Peregrine Falcon	*		*	C
Perdicula erythrorhyncha, Painted Bush-Quail	*		*	C
Galloperdix spadicea, Red Spurfowl	*		*	C
Gallus sonneratii, Grey Junglefowl	*	*	*	A/C
Columba elphinstonii, Nilgiri Wood-Pigeon	*		*	C/B
Chalcophaps indica, Emerald Dove			*	UC
Treron pompadora, Pompadour Green-Pigeon			*	R
Ducula badia, Mountain Imperial-Pigeon			*	R
Loriculus badia, Indian Hanging-Parrot	*	*	*	C
Psittacula cyanocephala, Plum-headed Parakeet	*			?
Psittacula columboides, Blue-winged Parakeet	*	*	*	C
Hierococcyx varius, Brainfever Bird	*			?
Cacomantis sonneratii, Banded Bay Cuckoo			*	R
Tyto capensis, Grass Owl			*	R
Otus sunia, Oriental Scops-Owl			*	C
Strix leptogrammica, Brown Wood-Owl			*	UC
Batrachostomus moniliger, Ceylon Frogmouth			*	R
Caprimulgus atripennis, Jerdon's Nightjar			*	UC
Collocalia unicolor, Indian Edible-nest Swiftlet			*	?
Tachymarptis melba, Alpine Swift			*	C
Harpactes fasciatus, Malabar Trogon			*	UC
Alcedo meninting, Blue-eared Kingfisher			*	R
Nyctyornis athertoni, Blue-bearded Bee-eater			*	UC
Merops orientalis, Small Bee-eater		*		?
Merops leschenaulti, Chestnut-headed Bee-eater	*		*	C
Ocyceros griseus, Malabar Grey Hornbill	*			?
Anthracoceros coronatus, Malabar Pied Hornbill#			*	-
Buceros bicornis, Great Pied Hornbill			*	R
Megalaima zeylanica, Brown-headed Barbet			*	C
Megalaima viridis, White-cheeked Barbet	*	*	*	C
Megalaima rubricapilla, Crimson-throated Barbet	*		*	UC
Picumnus innominatus, Speckled Piculet	*		*	C/B
Dryocopus javensis, Great Black Woodpecker	*		*	UC
Dinopium javanense, Common Golden-backed Woodpecker	*		*	C
Chrysocolaptes lucidus, Greater Golden-backed Woodpecker			*	C
Hemicircus canente, Heart-spotted Woodpecker	*		*	UC
Pitta brachyura, Indian Pitta			*	?
Galerida malabarica, Malabar Crested Lark	*		*	UC

Appendix 2: A checklist of birds of Kemmangundi $^{\alpha, \beta}$ (contd.)

Species	Sálim Ali	Shyamal	Thejaswi	Status
Hirundo rupestris, Eurasian Crag-Martin	*			?/W
Hirundo concolor, Dusky Crag-Martin	*		*	C
Hirundo rustica, Common Swallow		*		?/W
Hirundo daurica, Red-rumped Swallow	*	*		UC
Dendronanthus indicus, Forest Wagtail	*			?/W
Anthus rufulus, Paddyfield Pipit	*			?
Anthus similis, Brown Rock Pipit	*	*	*	C/B
Anthus hodgsoni, Oriental Tree Pipit	*	*		C/W
Coracina melanoptera, Black-headed Cuckoo-Shrike	*			?
Pericrocotus flammeus, Scarlet Minivet	*		*	R
Hemipus picatus, Pied Flycatcher-Shrike	*		*	C
Tephrodornis gularis, Large Woodshrike	*		*	C
Pycnonotus priocephalus, Grey-headed Bulbul			*	UC
Pycnonotus melanicterus, Black-crested Bulbul			*	C
Pycnonotus jocosus, Red-whiskered Bulbul	*	*	*	A/B
Iole indica, Yellow-browed Bulbul	*		*	C/B
Hypsipetes leucocephalus, Black Bulbul	*	*	*	C
Chloropsis aurifrons, Gold-fronted Chloropsis			*	UC
Irena puella, Asian Fairy-Bulebird			*	C
Lanius cristatus, Brown Shrike		*		?/W
Monticola cinclorhynchus, Blue-headed Rock-Thrush	*	*		C/W
Monticola solitarius, Blue Rock-Thrush	*			?/W
Myiophonus horsfieldii, Malabar Whistling-Thrush	*		*	C/B
Zoothera citrina, Orange-headed Thrush			*	C/POB
Zoothera dauma, Scaly Thrush			*	R
Turdus merula, Eurasian Blackbird	*		*	C/B
Brachypteryx major, White-bellied Shortwing	*		*	C
Luscinia brunnea, Indian Blue Robin	*			C/W
Copsychus saularis, Oriental Magpie-Robin	*	*	*	C
Copsychus malabaricus, White-rumped Shama			*	R
Saxicola torquata, Common Stonechat	*			?/W
Saxicola caprata, Pied Bushchat	*	*	*	C/B
Garrulax delesserti, Wynaad Laughingthrush			*	R
Garrulax jerdoni, Grey-breasted Laughingthrush			*	R/UC
Pellorneum ruficeps, Spotted Babbler	*	*	*	C
Pomatorhinus horsfieldii, Indian Scimitar-Babbler	*	*	*	C/B
Dumetia hyperythra, Rufous-bellied Babbler	*		*	UC
Rhopocichla atriceps, Black-headed Babbler	*		*	C
Turdoides subrufus, Indian Rufous Babbler		*	*	C
Turdoides striatus, Jungle Babbler#	*		*	C
Alcippe poioicephala, Quaker Tit-Babbler	*		*	C
Cisticola exilis, Golden-headed Fantail-Warbler	*		*	UC/R
Locustella naevia, Pale Grasshopper-Warbler	*			C/W
Acrocephalus dumetorum, Blyth's Reed Warbler		*		C/W
Phylloscopus affinis, Tickell's Warbler	*			C/W
Phylloscopus occipitalis, Western Crowned Warbler	*			C/W
Schoenicola platyura, Broad-tailed Grass-Warbler			*	R
Muscicapa dauurica, Asian Brown Flycatcher	*			?
Ficedula parva, Red-throated Flycatcher	*	*		C/W
Eumyias thalassina, Verditer Flycatcher		*		C/W
Eumyias albicaudata, Nilgiri Flycatcher	*		*	C/B

Appendix 2: A checklist of birds of Kemmangundi $^{\alpha, \beta}$ (contd.)

Species	Sálim Ali	Shyamal	Thejaswi	Status
Cyornis pallipes, White-bellied Blue-Flycatcher	*		*	C/B
Cyornis rubeculoides, Blue-throated Flycatcher	*			C/W
Cyornis tickelliae, Tickell's Blue-Flycatcher (?) $		*		?
Culicicapa ceylonensis, Grey-headed Flycatcher	*		*	C/PRB
Parus xanthogenys, Black-lored Yellow-Tit	*		*	C
Sitta frontalis, Velvet-fronted Nuthatch	*		*	C/B
Dicaeum agile, Thick-billed Flowerpecker			*	R
Dicaeum concolor, Plain Flowerpecker			*	R
Nectarinia minima, Small Sunbird	*	*	*	C
Arachnothera longirostra, Little Spiderhunter			*	UC
Zosterops palpebrosus, Oriental White-eye	*	*	*	A
Carpodacus erythrinus, Common Rosefinch	*			C/W
Lonchura kelaarti, Black-throated Munia			*	R
Sturnus malabaricus, Grey-headed Starling	*		*	C
Acridotheres fuscus, Jungle Myna			*	R
Gracula indica, Southern Hill-Myna			*	C
Oriolus oriolus, Eurasian Golden Oriole		*	*	?
Dicrurus leucophaeus, Ashy Drongo	*	*		C/W
Dicrurus aeneus, Bronzed Drongo	*		*	UC
Dicrurus paradiseus, Greater Racket-tailed Drongo	*		*	C
Dendrocitta leucogastra, White-bellied Treepie	*		*	C
Corvus macrorhynchos, Jungle Crow		*	*	R

$^{\alpha}$ - The list is by no means complete and stands at 125 species

$^{\beta}$ - Nomenclature follows Manakadan and Pittie (2001)

- The birds were sighted at *c.* 600 m in a coffee estate at the foothills of the range

$ - Not found in sholas, likely to be a *Cyornis rubricapilla* or a female *Cyornis pallipes* which are very similar

Status symbols

A - Abundant
B - Breeding confirmed
POB - Breeding possible
PRB - Breeding probable
C - Common
UC - Uncommon
R - Rare
W - Winter visitor
? - Status equivocal/unknown

Sálim Ali (1942-43) refers to the 67 species observed and collected by Sálim Ali on a six-day visit in January 1940 to Kemmangundi in course of his Mysore survey.
Shyamal (1993) is the checklist of 31 species, seen by L. Shyamal on a two-day visit in February 1993.
Thejaswi (2002) is the checklist of 97 species seen during my seven-day visit in May 2002.

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THE IRRAWADDY DOLPHINS *ORCAELLA BREVIROSTRIS* OF CHILIKA LAGOON, INDIA[1]

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The Irrawaddy Dolphin *Orcaella brevirostris*, known as 'Khera' in local parlance in Chilika, is a facultative cetacean species found both in fresh as well as coastal waters. It is also found in two lagoons – Chilika in India and Songkhla in Thailand. It is distributed in southeast Asia, extending to northern Australia. It was first described by Owen based on a specimen found in 1852, in the harbour of Vishakhapatnam on the east coast of India.

The status of the Irrawaddy Dolphin in its entire distribution range is not well known; however, the population is expected to be less than a thousand. Its population in Chilika is not more than 50. A maximum number of 31 dolphins were sighted during three surveys conducted in July, September and December, 2000. Except in the northern zone, which receives a heavy load of sediments through several tributaries of the River Mahanadi, these dolphins are found throughout Chilika lake. Deliberate killings of dolphins in Chilika have not been reported, but the species is under threat from intensive and extensive fishing, unorganised tourism using mechanised boats, and habitat degradation. At least 15 dolphins were found dead in the lagoon during 1999 and 2001. Immediate attention is required to protect the dolphins from being hit by mechanised boats and from drowning in fishing nets. Besides the habitat improvement programme being undertaken by the Chilika Development Authority, which will help in conserving the Chilika lagoon in general and the dolphins in particular, education and awareness among the masses and tourists is warranted. However, a Dolphin Conservation Programme would focus on the specific requirements and help in conserving the rare Irrawaddy Dolphins of Chilika.

Key words: Irrawaddy Dolphins, *Orcaella brevirostris*, Chilika Lagoon, status, threats, conservation

INTRODUCTION

Irrawaddy Dolphins *Orcaella brevirostris* primarily occur in the tropical-subtropical Indo-west Pacific, from northwest Bay of Bengal to northeastern Australia. The Irrawaddy Dolphin was first described by Owen (in Gray 1866) based on a specimen found in 1852, in the harbour of Vizagapatnam (now Vishakhapatnam) along the east coast of India. Unlike many cetaceans, it is a coastal species, also found in several major river systems of southeast Asia. Only two lagoon populations of Irrawaddy Dolphins are known in the world: Chilika in Orissa State, India and Songkhla in Thailand. Records are relatively few, though there are some areas of local abundance (Stacey and Arnold 1999).

DISTRIBUTION

In India, the Irrawaddy Dolphin has been recorded from Vishakhapatnam to the deltas of the Brahmaputra and Ganges (= Ganga) rivers (Anderson 1879; James *et al.* 1989). The brackish Chilika lagoon was an important habitat (Annandale 1915), but Irrawaddy Dolphins are now considered rare there (Dhandapani 1992). The species has been recorded in relatively small numbers in the coastal waters of Bangladesh (Kasuya and Haque 1972, Haque 1982), Myanmar (Smith *et al.* 1997b), peninsular Malaysia (Morzer Bruyns 1966; Stacey and Leatherwood 1997), Singapore (Pilleri and Gihr 1974), Thailand (Chantrapornsyl *et al.* 1996; Stacey and Leatherwood 1997), Sarawak (Gibson-Hill 1950; Pilleri and Gihr 1974), Sabah (Dolar *et al.* 1997), Brunei (Gibson-Hill 1949, 1950; Pilleri and Gihr 1974), and the Gulf of Papua (Dawbin 1972). The population status is unknown in all these areas, but numbers appear to be declining in the Gulf of Thailand where they are concentrated in the Thale Sap (= Songkhla Lake) region (Perrin *et al.* 1996) and the Laem Sing area (Stacey and Leatherwood 1997). Records from Sumatra, Java, Sulawesi, Kalimantan, and Irian Jaya are more numerous (Morzer Bruyns 1966; Stacey and Leatherwood 1997). Major concentrations are said to occur in the coastal areas of Cilacap on the southern coast of Java and Kalimantan (Perrin *et al.* 1996). Recently it has been recorded from Malampaya Sound in the Philippines. Records from northern Australia are numerous, extending from Broome, Western Australia to the east coast of Queensland as far south as the Brisbane river, Queensland (Paterson *et al.* 1998).

Orcaella brevirostris has been recorded in the Irrawaddy (= Ayeyarwady) river, from near Prome to about 50 km above Bhamo, about 1,300 km upstream (Anderson 1879; Thein 1977; Leatherwood *et al.* 1984; Smith *et al.* 1997b). There are records of the species from River Mekong in Vietnam and Cambodia, and a short distance into the Lao Peoples'

Democratic Republic (Baird *et al.* 1994; Baird and Mounsouphom 1994; Lloze 1973; Perrin *et al.* 1996; Smith *et al.* 1997a; Stacey and Leatherwood 1997). Recent information suggests that numbers throughout the Mekong river, as well as in the Sekong river in Laos, have been declining. The species has been recorded in the Mahakam river and Semayang Lake-Pela river of east Kalimantan, as well as the Kumay river of central Kalimantan (Tas'an and Leatherwood 1984; Perrin *et al.* 1996). There is no fossil record.

The Irrawaddy dolphin is locally known as '*Khera*' in the Chilika Lagoon area, and also '*Bashiyya Magar*' (oil yielding dolphin) in the Oriya language. It is known as *Pa kha* in Lao PDR and *Pesut Mahakam* or *Ikan pesut* in Indonesia; it is the provincial symbol of East Kalimantan (Perrin *et al.* 1996). The Malaysian name is *Lumba lumba* (Watson 1981). In Thailand, one of its names is *Pla loma hooa baht*, because its rounded head is thought to resemble the shape of a monk's bowl, a *hooa baht* (Baird and Mounsouphom, 1994).

STUDY AREA

Chilika Lagoon, commonly known as Chilika Lake, is the largest brackish waterbody in Asia. The pear-shaped lake is situated on the east coast of Orissa, India between 19° 28' and 19° 54' N and between 85° 05' and 85° 38' E (Fig. 1). The maximum north-south length is 63 km. The average width is 17.8 km (Satellite Imagery, October 2000) and total surface area is *c.* 845-sq. km (May, 2000) (IRS-IC, IRSS-III). The maximum depth of the lagoon varies between 3-4.5 m in the Central Sector near Kalijai Temple (Fig. 1). The catchment area of the lake is 3212 sq. km, not including the drainage of the Mahanadi. Altogether, 35 rivers and rivulets drain into the lake. There are several islands covering a total area of 223 sq. km. Chilika Lagoon runs parallel to the Bay of Bengal, separated by a 0.1-1.5 km narrow and 39 km long sand spit.

On September 23, 2000, a new mouth was opened opposite the village Sipakuda, 8 km from Satpada (Fig. 1), by desilting to restore the lagoon ecosystem. This increased salinity to 14 ppt in December 2000 at Satpada against the average salinity of 3-4 ppt in the same period for the last decade, resulting in an overall increase in fish, prawn and crab landings by 131%, 534% and 449% respectively, in 2000-2001 compared to the previous year.

The lake can be divided into four major ecological divisions: Outer Channel, Northern, Central and Southern Sectors. The Northern Sector is shallow as it receives silt from the rivers, whereas the Central and Southern Sectors are relatively deep.

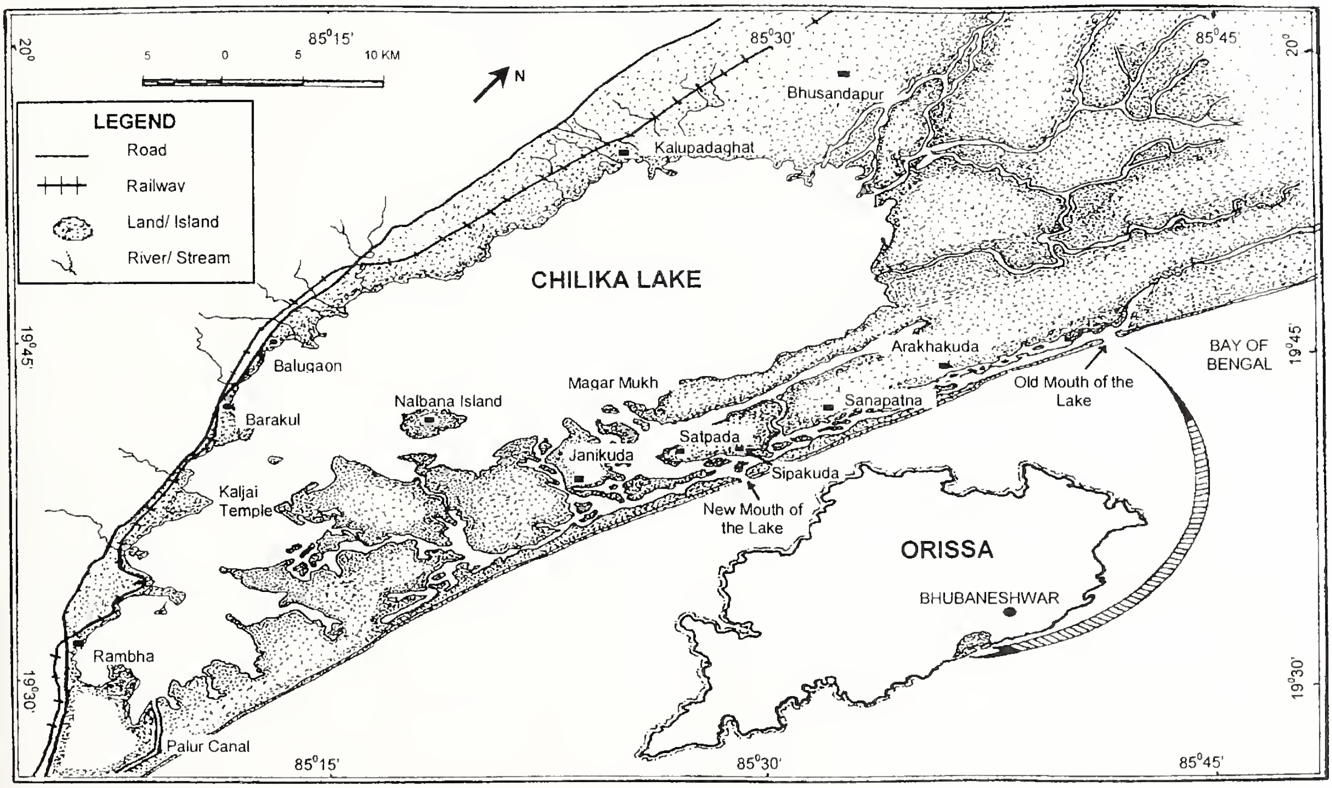
20°
85°15'
5 0 5 10 KM
N
85°30'
85°45'
20°
Bhusandapur
LEGEND
Road
Railway
Land/ Island
River/ Stream
Kalupadaghat
CHILIKA LAKE
19°45'
Balugaon
Barakul
Nalbana Island
Magar Mukh
Arakhakuda
Sanapatna
Old Mouth of the Lake
BAY OF BENGAL
19°45'
Satpada
Janikuda
Sipakuda
Kaljai Temple
New Mouth of the Lake
ORISSA
BHUBANESHWAR
Rambha
19°30'
19°30'
Palur Canal
85°15'
85°30'
85°45'

Fig. 1: Map of Chilika Lagoon

The lake is highly productive, with rich fishery resources (Chilika = fish in local parlance, which probably gave the lake its name). It sustains about 1.5 lakh fisherfolk of 12,363 families in 132 villages in its environs. The total number of active fishermen is estimated at 30,000.

METHODS

On the initiative and support of the Chilika Development Authority, rapid surveys were conducted in June, September and December 2000 to determine the current status and distribution of the Irrawaddy Dolphins in the lake.

During the surveys, we interviewed fishermen whom we met at the lake to obtain information regarding the occurrence, distribution, threats, conservation, and cultural attitudes regarding protection of dolphins. Repeating questions to different fishermen increased the reliability of information provided by the informants. The fishermen associated with the Dolphin Motorboat Association, and Mr. Shial, the Assistant Tourist Officer of Orissa Tourism Department at Satpada were interviewed to collect information on the number of tourists visiting Chilika for dolphin watch.

RESULTS AND DISCUSSION

Dolphin Population in different Ecological Zones of the lake

Surveys were conducted for nine days between June and December, 2000 in the Outer, Central, Southern and Northern sectors of Chilika lagoon. A total of 50 hours were spent searching for dolphins. Most of the dolphins were sighted in the Outer Channel, mainly between Magarmukh and New Mouth at Sipakuda (Fig. 1).

Outer Channel: Surveys in the Outer Channel were conducted on June 9 and 10, September 2, and December 26 and 28, 2000. On June 9, the survey was conducted from Satpada to Sipakuda (New Mouth), 8 km; and Satpada to Mahisha - Brahmpur - Rajhans Forest Rest House (*c.*12 km).

A total of about 30 dolphins were sighted in the Outer Channel in a stretch of about 12-13 km between Magarmukh and New Mouth at Sipakuda. In June only 13 adults were sighted, whereas in September 19 adults, two juveniles and one calf were sighted. In December, 30 adults and one calf were sighted (Table 1) in the outer channel. The choppy surface of the lake, due to high breeze from the Bay of Bengal, led to poor sighting of dolphins in June. The New Mouth at Sipakuda was opened on September 23, after which the fish catch increased significantly. In December the calmer water surface, compared to June and September, facilitated the dolphins sightings.

Table 1: Dolphin sightings in Chilika Lagoon (June-December, 2000)

	Outer Channel	Northern Sector	Central Sector	Southern Sector	Total
Jun.-Jul.	13 adults	Not done	6 adults	4*	23 adults
Aug.-Sep.	19 adults 02 juveniles 01 calf	Nil	4**	2***	25 adults 02 juveniles 01 calf
Dec.	30 adults 01 calf	Not done	Nil	Not done	30 adults 01 calf

* and **: Sighted by Mr. Bishnu of CDA on July 21 and August 20 respectively

***: Sighted by local fishermen

Central and Southern Sectors: The Central and Southern part of the lake were surveyed on June 11, September 1 and December 27, 2000 (only Central Sector). On June 11, we surveyed for about 10 hours. Six adult dolphins were sighted in the Nalabana Bird Sanctuary in the Central Sector. In this area, no fishing activity was noticed, but fishing is reportedly done at night. No dolphin was sighted in the Southern Sector, but one of the researchers of the Chilika Development Authority, Mr. Bishnu, sighted 4 adults each in the Southern Sector and Central Sector on July 21 and August 20, during a monthly limnological sampling of the lake. On September 1, the survey was started from Barkul, a small town on the western end of the Central Sector about 5-6 km from Kalijai Temple Rock Island, to cover the Central and Southern sectors, but no dolphins were sighted. However, the local fishermen reported sightings of 2-3 adults near Rambha in the Southern Sector. Though no dolphin could be sighted in the Central and Southern Sectors in September, it can be reasonably accepted that dolphins are found in these sectors in the monsoon, i.e. June to September. However, the population density is very low as compared to the Outer Channel.

Northern Sector: Due to insufficient water, surveys could not be conducted in this sector in June and December. However, on September 3 we surveyed almost the entire Northern Sector, which receives fresh water from a large number of tributaries of the River Mahanadi, resulting in highly turbid water in the lake. A major portion of the lake in this sector was infested with weeds, which have severely affected the dolphin habitat here. We could not sight any dolphins, but the local fishermen informed us of regular sightings in the area about 20 years ago. In the 1999 monsoon, one dolphin was sighted in this sector (Bishnu *pers. comm.*).

Dhandapani (1992) estimated only 20 dolphins in the lake. During the three surveys in June, September, and December 2000, the total number of dolphins in Chilika was estimated to be more than 30, though the entire lake was not

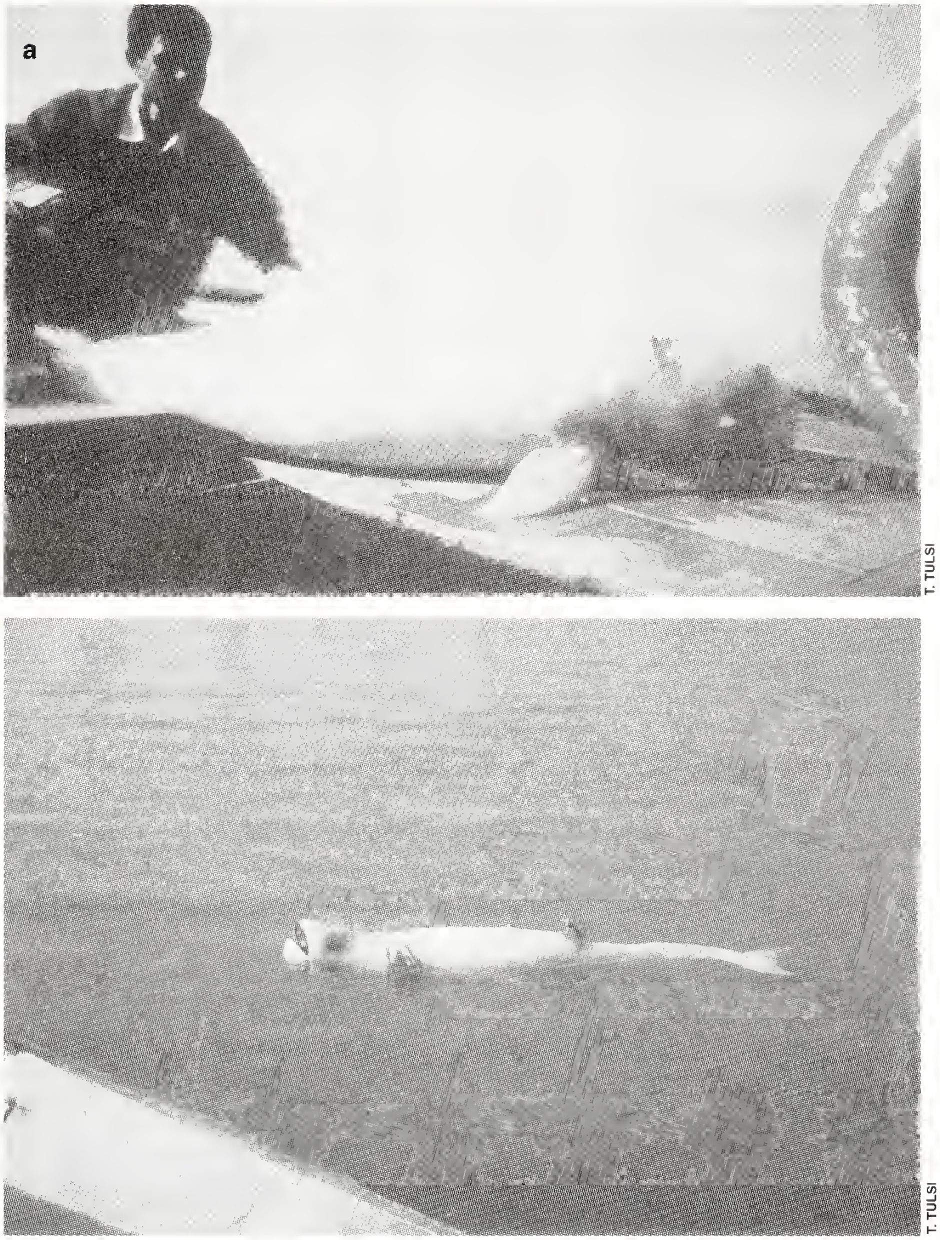

Fig. 2: a. A dead Irrawaddy Dolphin on the Central Sector of the Chilika Lagoon, probably hit by a mechanized boat; b. The wound on the neck can be seen

thoroughly and systematically surveyed for various reasons. Taking the size of the lake and width of the Outer Channel into account, some dolphins must have been missed during the survey. Optimistically, the expected number of dolphins in Chilika would be 40-50.

CONSERVATION STATUS

The species is listed as IUCN category K, i.e., insufficiently known (Klinowaska 1991). Irrawaddy Dolphins are protected under the Indian Wildlife (Protection) Act, 1972; hunting, capture and trade in the species is illegal. Besides India, the species has been given legal protection in Laos, Cambodia, Indonesia, and Australia; however, enforcement is a problem (Stacey and Arnold 1999). Fifteen dolphins were killed in Chilika Lagoon in 1999 and 2000. One carcass of a calf was collected by Mr. Bishnu, a researcher of the Chilika Development Authority (CDA), from the lagoon 4-5 km east of Kalijai Temple Rock Island on November 23, 1999. It is preserved in the museum of the CDA at Bhubaneshwar. The calf was probably entangled in a gill net, as blood was oozing from a wound near the gape of the calf at the time of collection.

In the Central Sector, another adult carcass was sighted floating in February 2000, which was left in the lake (Bishnu *pers. comm.*). An adult female carcass (2 m) was collected from the Outer Channel on September 24, 2000 at Satpada. Again in January 2001, two adult dolphins 2.0 and 2.2 m long were found dead in the Outer Channel. Thus, between November 1999 and January 2001 six carcasses of Irrawaddy Dolphins were found in the lagoon, which is unfortunate and endangers the survival of these dolphins, considering the small population. Besides these, the State Forest and Wildlife Department collected some more carcasses. Two skeletons are lying in their museum at Barkul, while many have reportedly been buried in the Nalabana area in the Lake. In January 2002, four more dolphins were killed by the mechanised tourists boats, one of which was photographed (Fig. 2).

During the present study, the dolphins were sighted in the main area of the lake in June at the approach of the monsoon, and in the Outer Channel in September when monsoon was at its peak. If locals are to be believed, the dolphins are sighted in the lake throughout the monsoon, i.e. July-September.

During the present study, Irrawaddy Dolphins were found swimming slowly, with sluggish movements. In spite of a choppy lake surface most of the time, the melon, dorsal fin and fluke were clearly visible. The blow sound of respiration was heard many times. In the main part of the lake, 6 dolphins were observed in a semi-circular formation, probably driving fish in a particular area for community feeding. Occasionally they moved fast and vigorously, probably when chasing fish.

People's perception about the Irrawaddy dolphin in Chilika

In Chilika Lake, Irrawaddy Dolphins were observed swimming in the vicinity of a few metres of small seine-fishing nets and also following boats. Annandale, in the early part of the 20th Century, also sighted dolphins following boats in Chilika. Interest in dolphin conservation and awareness was noticed everywhere in Chilika, and many fishermen and villagers were seen to respect dolphins. Most fishermen believe that killing dolphins brings bad luck, while saving one ensures a good catch. The local fishermen reported that whenever a dolphin gets entangled in a fishing net, it 'cries' for help by making specific sounds to attract attention. The fishermen's good intentions of rescuing and releasing the dolphins entangled in gill-nets, however, are not always possible, as they hesitate to cut open their nets to release the dolphins. This results in the dolphins getting drowned. The author observed this conflict among many of the fishermen.

Some fishermen are experts in calling dolphins by producing a sound "*ku ku ku ku*..." for help while fishing. They also reportedly call Irrawaddy Dolphins by striking the side of the boat with a conical wooden pin, as has been observed in the Irrawaddy river in Myanmar (Smith *et al.* 1997b).

There is generally a positive attitude towards dolphins in many southeast Asian countries, with beliefs that dolphins have saved drowning swimmers, offered protection against crocodiles, and assisted in fishing operations (Stacey and Leatherwood 1997; Thein, 1977).

At the old mouth of Chilika, the local fishermen reported that during high tide, especially on Full and No Moon days and nights, 5-10 Bottlenose Dolphins enter through the Old Mouth from the sea up to Sanapatna, 15 km inside the Outer Channel, and return to the sea with low tide.

Kaminga *et al.* (1983) suggested that *Orcaella* was forced inshore by more specialised dolphins, implying exclusion by inter-specific competition. Stacey and Leatherwood (1997) also reported that when captive Humpback Dolphins (*Sousa chinensis*) and Irrawaddy Dolphins were held together, the former was dominant. Irrawaddy Dolphins were frequently chased and confined to a small portion of the tank. During the September survey, the local fishermen reported that whenever the Irrawaddy Dolphins and Bottlenose Dolphins came across one another in the Outer Channel, the former got frightened and was forced to return. This corroborates the above observations.

The Irrawaddy Dolphins – a Tourist Attraction at Chilika

Orissa has many archaeological and religious sites, which attract thousands of tourists from all over the world. Satpada on Chilika Lagoon is about 50 km south of the famous Puri shrine. The main attraction in Chilika, especially at Satpada is the Irrawaddy Dolphin. Data collected from the records of the Orissa Tourism Department and the Dolphin Motorboat Association, an NGO at Satpada, revealed that about 40,000 tourists visit Chilika every year. October-January and May-June are the peak season for tourists at Chilika, with a maximum 600-700 per day during December-January. The Dolphin Motorboat Association has 75 motorboats for dolphin watch. Tourists pay Rs. 250 for 60-90 minutes per boat, that has a capacity of eight persons. According to the Association, most tourists see dolphins, but 5% return disappointed. Besides the Association, the Orissa Tourism Department also organises 'dolphin-watch' for tourists. Even during monsoon, about 100 tourists visit the lake every day. This confirms that dolphins are sighted even during monsoon in the Chilika Lake. This is probably the only tourist spot in India for dolphin sightings and has 'organised dolphin-watch agencies'. As the 'dolphin-watch' is not organised by properly trained boatmen, dolphins are sometimes seriously injured. At the request of the tourist, the boatmen continuously chase dolphins, which are hit by the boat propellers while frantically trying to escape.

Threats to Dolphin Population in Chilika Lagoon

Directed catch: Directed killing of dolphins in Chilika Lagoon to obtain oil was reported by Annandale (1915) in the early 20th Century. Dhandapani (1992) also recorded harpooning of 4 or 5 dolphins per year in Chilika during mid-1980s, but he recorded only two dead dolphins during his two year study. During the present study, no incidence of directed killing was observed, but it cannot be ruled out.

Incidental catch: Incidental catches in fishing nets have been reported from Bangladesh (Haque 1982), Myanmar (Leatherwood *et al.* 1984; Smith *et al.* 1997b), Thailand (Andersen and Kinze 1994), and the Lao-Cambodian border (Baird and Mounsouphom 1994). About 15 Irrawaddy Dolphins were killed incidentally in Chilika Lake in the last two years, the carcasses of which have either been buried or preserved by the Wildlife Department or Chilika Development Authority.

The fishing dragnets like 'Sahala jal', 'Bhetki jal' and 'Patna jal' operating in Chilika Lake are highly dangerous for the dolphins, entangling and ultimately drowning many of them.

Habitat degradation

Habitat degradation includes increased use of nylon gill nets, increased vessel traffic (e.g., associated with logging in Kalimantan), reduction in food resources (e.g. due to trawling in the Gulf of Thailand), pollution, and sedimentation of lakes. The physiography of the lake is changing due to geological causes, as well as human intervention.

Originally Chilika Lagoon was part of the sea. Gradually it became shallow due to siltation from the tributaries of River Mahanadi and the low mud-flats that have been pushing their way southward from the mouths of the rivers in the Northern Sector of the lake. The lake was formed from the sea some 3550 to 3950 years before present, when it was like a bay. The deepest portion was near Kalijai Temple Rock Island, measuring 4.5 m. It has been reported that the silt deposition has raised the lake bed by 1.8 m near Kalijai Temple in the last seven decades. Siltation in Chilika can be attributed as one of the principal factors endangering the lake and in turn the dolphin habitat. No reliable estimates of sedimentation are available.

Chilika Lake had scanty aquatic vegetation in the early part of the 20th Century. The Remote Sensing Data of IRSIA, to estimate the growth rate of vegetation in Chilika, revealed that the waterspread had reduced at the rate of 23.42 sq. km over five years between 1984 and 1989 for emergent vegetation. Another study using satellite data analysis revealed that the weed-covered area in the lagoon was 20, 60, 200 and 398 sq. km during 1973, 1977, 1985 and 1993, respectively. Thus, within 20 years, the weed-covered area had increased 20 times. *Potamogeton pectinatus* is the dominant weed in the Central and fringes of Southern Sector, whereas *Scirpus littoralis* is dominant in the Northern Sector. This drastic reduction in habitat area, both horizontally and bathymetrically, has reduced and degraded the habitat for the Irrawaddy Dolphins in Chilika Lagoon.

The total fish catch in Chilika has declined from 6,000 metric tons per year to 2,000 metric tons in the last 14 years. This can be attributed to over-fishing, obstruction of migratory route, i.e. choking of the mouth, as well as the entire 'Outer Channel' up to Magarmukh, destruction of spawn during collection of prawn seeds by the local fishermen, among others.

Chilika Lagoon faces threats from increase in freshwater weeds, aquaculture, decline in fish production, changes in species composition of fishes and other biota, eutrophication and overall loss of biodiversity. Depletion of fishery has resulted from over-dependence of people on the lake, beyond its carrying capacity. Moreover, encroachments upon the traditional fishing rights of the local fishermen occasionally lead to inter-community conflict and violence. The CDA has planned for lake traffic using a big barge to transport buses, lorries etc., which is likely to increase pollution, as well as the danger of casualties of dolphins.

Hundreds of motorboats ferry local villagers, fishermen as well as tourists in the lake. This results in noise as well as oil pollution, both of which are dangerous to the dolphins. Habitat destruction and degradation, and noise pollution as potential threats to Irrawaddy Dolphins have also been reported from Australia (Paterson *et al.* 1998).

Recommended Conservation Action Plan for Irrawaddy Dolphins in Chilika

As per the IUCN – World Conservation Union, the status of the Irrawaddy Dolphin is insufficiently known. Workers throughout its distribution range opine that the numbers are declining and measures to prevent further decline are called for. The most pressing conservation issue affecting the survival of Irrawaddy Dolphins is habitat degradation. Incidental catch is also a matter of great concern, especially if the population is as small as in the Chilika Lagoon. Conservation includes economic, political, cultural and biological components. A cultural approach is certainly called for in the case of Irrawaddy Dolphins in Chilika, where people have a positive attitude towards them, very little direct catch and people do not need to be convinced that dolphins are worth more alive than dead.

It is clear that dolphins cannot be protected in isolation unless dedicated programmes are initiated to protect them and restore their habitat. Incidental catch and frantic chase of the dolphins may be reduced through awareness and education campaign among local communities. The conservation focus must be on habitat conservation and restoration. The following activities are recommended for dolphin conservation in Chilika Lagoon:

1. Monitor the abundance of Irrawaddy Dolphins throughout the lagoon every month or at least once in two months using standard techniques, namely carefully designed line and strip transects and mark-recapture studies by photo-identification. Identification of areas of great abundance will help in assessing conservation priorities.

2. Tissue samples should be collected from dead/drowned dolphins and such samples should be used to study genetics to identify population discreetness and variation. If separate populations are identified, conservation efforts need to be applied in all areas. The estimation of contaminant levels in the tissues of the species will help in formulating conservation efforts so far as pollution level in the lake is concerned.

3. Sustainable and less wasteful fishing methods should be developed, with scientific and community development and education components. The IUCN has also identified Chilika as a suitable site for such a programme.

4. Research is needed to study the impact of water traffic in the lake. Such studies should examine incidental killings, pollution load due to the river traffic and impact of noise pollution on the dolphins. The CDA is planning to operate a transport barge in the lake. Such study will be useful to mitigate the likely impact of such developmental activities: motorised vessels, noise pollution.

5. Detailed study should be carried out on dolphin biology, ecology, and behaviour in response to human interaction. Morphological data of every carcass should be collected, which would be useful in taxonomic studies.

6. Habitat preference, population dynamics, and reproductive behaviour of the dolphins should be studied.

7. Infrastructure to promote tourism based on ecological principles should be created for financial benefits to the local community, including training of boatmen. This will motivate the locals to save the dolphins, and generate additional income and employment for them. It will also reduce the pressure on the fishery of the lake.

8. Fishing at the mouth of the lake should be discouraged and, if possible, banned. Only subsistence fishing may be allowed. It will increase availability of fish in the lake.

9. Measures must be taken to check the increasing growth of weeds.

10. It is essential to study the nature and rate of sedimentation of the lake and to take ameliorative steps to control it. This may be achieved by intensive and extensive tree and shrub plantation in the catchment areas of the lake. This will maintain the depth and waterspread of the lake.

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ECOBIOLOGY OF INDIAN WILD BUFFALO *BUBALUS ARNEE* L. IN UDANTI WILDLIFE SANCTUARY, CHHATTISGARH, INDIA[1]

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The Indian Wild Buffalo (*Bubalus arnee* L.) is an endangered species according to the criteria of the IUCN, categorized in Appendix III of CITES and in Schedule I of the Wildlife (Protection) Act, 1972 of India. These studies were conducted in Udanti Wildlife Sanctuary, Chhattisgarh State, India. The species has been declared as the State animal of Chhattisgarh. The Sanctuary is a good habitat for Wild Buffalo, having easily available fodder, shelter and water. However, there are a number of threats to the natural habitat from human habitation, agriculture, livestock grazing, forest fires and collection of forest products. To conserve the species and its potential good habitat in the Sanctuary, it is necessary to involve the concerned local people in the management of the area.

Key words: Endangered species, habitat, welfare factors, genetic swarming, wallowing, grazing

INTRODUCTION

The Udanti Wildlife Sanctuary includes the best potential habitat for the Indian Wild Buffalo in Central India. Udanti was declared a wildlife sanctuary (IUCN Protected Area category IV) in 1985. Spread over 237.27 sq. km, the Sanctuary is located between 82° 11' 10" - 82° 24' 10" E and 19° 55' 30" - 20° 11' 15" N. The forests of the Sanctuary are tropical moist and tropical dry deciduous types with Sal (*Shorea robusta)* and mixed species (Champion and Seth 1968). They have a rich component of flora and fauna. Besides Wild Buffalo, the other important animals in the Sanctuary are *Axis axis*, *Cervus unicolor*, *Muntiacus muntjak*, *Boselaphus tragocamelus*, *Bos gaurus*, *Sus scrofa*, *Presbytis entellus*, *Panthera tigris*, *P. pardus*, and a large number of birds and reptiles.

There are three seasons, namely monsoon (July to October), winter (November to February) and summer (March to June). The average annual rainfall of the area is *c.* 1,200 mm. The temperature reaches a maximum of 44 °C in summer and minimum 5 °C in winter.

MATERIAL AND METHODS

Wild Buffaloes are shy animals and spend the major part of their time in dense forests, particularly during the day. The inferences of the three year study from 1998 to 2000 are based on direct observations of the wild buffalo and the habitat. Observations were made early morning, at noon and in the evening, over a period of 10 to 15 days in all three seasons. The observations were repeated three times in each season. Most of the observations were made from temporary *machans* (observation towers) on trees. *Machans* were constructed at select places near the drinking, feeding and resting places of the Wild Buffalo. The animals were observed with the help of 7 x 50 and 20 x 50 binoculars. Observations were made while moving on foot, and also in vehicles, visiting different places from time to time. All possible areas of the Wild Buffalo habitat in the Sanctuary were surveyed. Several herds were observed in various forest beats, mostly near ponds.

OBSERVATIONS

Distribution: In peninsular India, the Wild Buffalo population survives in small scattered populations in some Protected Areas, particularly in Udanti Wildlife Sanctuary of Chhattisgarh State in India (Table 1). All these populations of Wild Buffalo are considered genetically pure.

Habitat: The areas under various vegetation types in different parts of the Sanctuary were mapped by remote sensing and field observations. The Sanctuary area under Sal forest is 20%, miscellaneous dense forest 37%, miscellaneous forest with bamboo 3%, open miscellaneous forest with grass 8%, miscellaneous medium density forest with grass 19%, and scrub 9%. The area under agriculture and habitation is 4%, while only 0.6% lies under water bodies (Mishra 2001b).

Home range: The home range of the Wild Buffalo in the Sanctuary was determined through remote sensing data and field observations. Six forest beats in 26 forest compartments, with a total area of 63.77 sq. km, are favourable for Wild Buffalo.

Food and water: Wild Buffalo generally feed on grass, but also browse on saplings of trees. They feed in this manner during winter and summer, as less grass is available then than

Table 1: Present distribution and population of the Indian Wild Buffalo (*Bubalus arnee* L.) in India

Sl. No.	Name of NP/WLS	Total area (sq. km)	Name of State	Estimated Wild buffalo population
1	Kaziranga NP	430	Assam	1666[1]
2	Manas Tiger Reserve	2840	Assam	100[2]
3	Pabha Wildlife Sanctuary	49	Assam	25[3]
4	Indravati NP & Tiger Reserve	1258	Chhattisgarh	25-30[4]
5	Bhairamgarh WLS	136.38	Chhattisgarh	10[5]
6	Udanti WLS	237.27	Chhattisgarh	35-40[6]

Data Source:

[1]: Wild Buffalo census in Kaziranga, The Rhino Foundation for Nature in NE India, Newsletter No. 3, June, 2001

[2]: G. Chetri, Research Officer, Manas Tiger Reserve (*pers. comm.*, February 3, 2000)

[3]: Various literature

[4]: Status survey report, team of BNHS, WII, Ranjitsinh *et al.* 2000

[5]: Status survey report, team of BNHS, WII, Ranjitsinh *et al.* 2000

[6]: Present study Mishra, 2001b

in the monsoon. A large variety of grasses occur in the Sanctuary, mostly during the monsoon. Wild Buffalo browse on saplings of *Shorea robusta*, *Pterocarpus marsupium*, and *Bridelia retusa*, among others. Grass species like *Heteropogon contortus* are commonly available in the Sanctuary area, but the Wild Buffalo prefers only immature tillers. Other important grass species, like *Andropogon pumillus*, *Apluda mutica*, *Aristida setacea*, *Digitaria granularis*, *Eragrostis pilosa*, *Imperata cylindrica*, species of *Panicum*, *Saccharum* and *Themeda* are commonly found in the Sanctuary area. There are five types of water sources in the Sanctuary, namely river, pond, anicut, jhiria and nullah bed. Udanti and Indravan rivers are seasonal sources of water while a few ponds are perennial water sources. There are more than 18 ponds in the valley and plains, which retain seasonal water, and about four of them retain water throughout the year. The animals generally use these ponds for drinking and wallowing, particularly during summer.

Seasonal and daily movements: The animals generally grazed more actively during the evening to late night. The monsoons are more favourable for the Wild Buffalo, as green grass and large quantities of water for drinking and wallowing are available. They sometimes move to nearby crop fields for grazing. Crops like paddy (*Oryza sativa)*, kulthi (*Dolichos biflorus*), urad (*Vigna mungo*) and sarson (*Brassica campestris)* are grown in the area during winter and these are favoured by Wild Buffalo. The female buffaloes are more active than the male. Besides some small hills, the wild buffaloes move in the entire valley and plain area in the Sanctuary. Maximum movements were recorded during summer. They migrate to other areas like the Sitanadi Wildlife Sanctuary and surrounding forest areas in search of water, fodder, and cover. They spend a lot of time during the monsoon and winter in the mixed forest, but with the advent of the hot weather move into the valley areas of Sal (*Shorea robusta*) forest. The daily movements of a herd average 7-8 sq. km, but sometimes considerably more, particularly during summer. The animals move slowly in a line while grazing. They cannot run fast in the forest, but they were observed running slowly during the breeding season. An adult female buffalo usually leads the herd during grazing and walking. The yearlings and calves are kept in the middle of the herd while adults remain at the back. The animals always remain alert during grazing or walking.

Behaviour: The Wild Buffalo requires large quantities of water for drinking and wallowing. The animals usually graze near water holes especially during summer. It was observed that at a time the male drinks for about 3 minutes during summer, which is the longest recorded drinking time, and about 1.5 minutes during the monsoon, which is the shortest recorded time. The wallowing time of the Wild Buffalo was also recorded during the study. A herd of Wild Buffalo wallowed for more than 55 minutes during summer. The animals like wallowing in the ponds for longer durations particularly during summer, but a number of biotic disturbances affect their normal activities (Mishra 2001a, Kotwal and Mishra 2003). It is difficult to know precisely the population and composition of Wild Buffalo in the Sanctuary. The official record for the year 2000 was 78 animals. According to our observations, there are nearly 40 Wild Buffaloes in the Sanctuary.

The Wild Buffalo share their habitat with other animals. A Blue Bull was observed grazing with a herd of Wild Buffalo near Deojhar Amli pond in the Sanctuary. The Blue Bull waited for the buffaloes and rested in the shade of trees while the buffaloes wallowed in the pond. A good association was observed between Spotted Deer and Wild Buffalo in the Sanctuary, where a herd of Spotted Deer grazed with a solitary buffalo bull near Amar pond.

Problems for Wild Buffalo in Udanti Wildlife Sanctuary

There are 18 villages inside the Sanctuary with a human population of 3,900 and about 4000 livestock, comprising of cattle, domestic buffaloes, goat etc. Since more than 70% of the human population are dependent on the Sanctuary for fuel wood, timber and NTFPs, several conflicts occur between the locals and the wild animals, including Wild Buffalo. Many villages are situated in the prime Wild Buffalo habitat and people continue to move in the area. The plain areas where good palatable grass can grow are encroached on by locals for agriculture. Due to the paucity of grasses, the wild animals sometimes graze on agricultural lands. While trying to save their crops, people sometime kill or injure the Wild Buffalo. Besides grazing competition, the livestock also poses a problem of disease and genetic swarming. Water is a limiting factor in summer. The use of common water holes by wild animals and livestock is a cause of conflicts and conveyance of diseases. Forest fire is the main problem in the Sanctuary. Forest fires burned about 60 to 70% of the Sanctuary area during 1999-2001. The common diseases reported from the area are rinderpest, and "foot and mouth" disease. Several other bacterial diseases are also reported. The disease infected cattle graze in grassland where wild animals also graze. Thus, contagious diseases are transferred from cattle to wild animals. There are many packs of wild dogs in the Sanctuary that prey on calves of Wild Buffalo.

Recommendations for management of the Wild Buffalo

1. The pure race of Wild Buffalo should be protected from possible genetic swarming from domestic buffalo by declaring the Sanctuary out of bonds for the domestic buffalo.
2. Five villages situated in prime Wild Buffalo habitat should be relocated outside the Sanctuary. There should be a restriction on the numbers of livestock, and these should be fed rather than allowed to graze free in the forest.
3. The domestic cattle are potential carriers of contagious diseases. Therefore, all the cattle around the Sanctuary must be immunized every year.
4. The locals should be involved in several management activities of the Sanctuary, such as protection, fire fighting, maintenance of water holes, roads, buildings and eco-development practices. They should be sensitized towards nature conservation.
5. The forest corridors around the Sanctuary should be strengthened.
6. The interface conflicts in the Sanctuary should be regularly monitored.

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AN EVALUATION OF CROP PROTECTION METHODS IN KERALA[1]

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Increasing incidence of crop depredation by wild animals have led to the use of several methods to protect crops in wildlife areas. An evaluation of the effectiveness of various protection methods used in 20 different Forest Ranges of Kerala between June 1994 and December 1994 is attempted, and the advantages and disadvantages of each discussed. Areas with crop depredation were visited to collect information on the methods employed for crop protection, their functioning and effectiveness. Guarding with ordinary fencing, stonewall fencing, line crackers, chemicals, trenches and electric fencing were the major control measures in practice. Electric fencing, though it required high initial investments, was the most effective against most of the animals.

Key words: Crop protection, electric fencing, wild animals, Kerala

INTRODUCTION

As the incidence of crop depredation by wild animals increases, so do methods to protect crops in wildlife areas. These methods could be effective for a long or short term, depending on the animal as well as the method used. Several control measures are used under different conditions and most researchers agree that the use of electric fencing and trenches are the most effective (Sukumar 1985, 1986; Schultz 1986, 1988; Santiapillai and Jackson 1990; Banerjee 1994; Chandrasekaran 1994; Shetty 1994; Bist 1996). Morris (1958) has mentioned the use of bamboo gun rocket for scaring away wild animals. Thorny branches of *Acacia* were used as brushwood fences in Haryana and Madhya Pradesh (Chauhan and Sawarkar 1989; Chauhan and Singh 1990). Use of trained dogs to chase crop-raiding deer was reported by Beringer *et al.* (1994). Swihart and Conover (1990) reported the use of big game repellent RO°PEL and soap to reduce crop damage by deer. Recent reports from Zimbabwe mention the use of a capsicum-based aerosol as elephant repellent (Osborn 1998). However, its effect is short term and can be used only for short to intermediate ranges. The traditional methods for deterring crop-raiding elephants, such as fire, brush fences and sound making devices have generally failed, except when the animals are close (Bell and McShane-Caluzi 1984). Jayawardene (1994, 1995, 1997) reported the effectiveness of electric fences against crop-raiding elephants in Sri Lanka. Thouless and Sakwa (1995a, b) assessed the effectiveness of electric fences in Northern Kenya and suggested that they be backed by special protection.

A total of 1310 cases of crop damage by wild animals were recorded throughout Kerala between 1981-1994. A total amount of Rs. 1,06,24,689 were claimed as compensation in the State for crop damage, of these Rs. 8,66,977 have been paid as compensation and form only 8.16% of the total claims (Veeramani 1998). Easa *et al.* (1998), Jayson (1998) and Veeramani (1998) have discussed the crop protection methods employed in Kerala. The present investigation evaluates the effectiveness of various protection methods employed in different parts of Kerala.

STUDY AREA

Kerala State, which lies in the southern part of the Western Ghats, is unique in environmental characteristics due to its geographical location (between 8° 18' and 12° 48' N and between 74° 52' and 77° 22' E) and topography. It is bounded on the eastern side by the Western Ghats ranges and to the west by the Arabian Sea. The state can be classified into three topographical regions, namely the coastal area, midlands and the highlands. The forest areas lie mostly in the highlands. The state has a forest cover of 9,400 sq. km (Anon. 1997). About 24% of the forest area lies within the protected area network comprising 12 wildlife sanctuaries and 2 national parks. The forest areas have been subjected to alterations of various degrees for agriculture, developmental programmes and settlements. Most of the forest areas have human habitations in the fringes and in some cases scattered settlements within. The majority of the settlements cultivate a variety of crops, which are prone to damage by wild animals. The agro-based economy of Kerala depends a lot on cash crops such as coffee, pepper, tea, cardamom and rubber, cultivated mostly in the highlands. The state has a good number of mammal species representing various taxa, such as Elephant (*Elephas maximus*), Gaur (*Bos frontalis*), Sambar

(*Cervus unicolor*), Chital (*Axis axis*), Wild Boar (*Sus scrofa*), Porcupine (*Hystrix indica*), and Bonnet Macaque (*Macaca radiata*).

METHODS

The study was carried out between June 1994 and December 1994. A total of ninety-five Territorial and Wildlife Ranges under five Forest Circles were considered for this study. Of these, four were selected randomly from each of the forest circles (Table 1). Two settlements with intensive crop depredation problems, one each in the enclosure and the periphery, were chosen in each of the selected Forest Ranges. These settlements were visited once and 1 km long transects laid, starting from the forest boundary. Plots of 10 sq. m were laid at every 100 m along the transect.

For each study plot, details of crop species in the plot, number of damaged and undamaged crop plants, phenology, animal causing the damage, nature of damage and protection method employed at the time of visit, were recorded. Enquiries were also made with the cultivators in the area to confirm the animal species involved in raiding, and other details such as the date and time of the raids. Care was taken to cover the areas within a single season and at the time of cultivation.

The damaged areas were visited, and details like crops damage, animal species involved, type of control measures, including the cost and efficiency of the method used, were recorded. Sample plots of 10 sq. m were laid to determine the efficacy of a method.

Table 1: Selected forest Ranges and its Divisions and Circles

Sl. No.	Range	Division	Circle
1	Kannavam	Kannur	Northern Circle
2	Kurichiat	Wynaad (WL)	
3	Kalpetta	South Wynaad	
4	Chedleth	South Wynaad	
5	Edavanna	North Nilambur	Olavacode Circle
6	Nelliampathy	Nemmara	
7	Attapadi	Mannarkad	
8	Agali	Mannarkad	
9	Chimmony	Chalakudi	Central Circle
10	Vellikulangara	Chalakudi	
11	Sholayar	Vazhachal	
12	Kollathirumedu	Vazhachal	
13	Marayur	Munnar	High Range Circle
14	Adimali	Munnar	
15	Idukki	Idukki	
16	Kaliyar	Kothamangalam	
17	Agasthyavanam	Trivandrum (WL)	Southern Circle
18	Palode	Trivandrum	
19	Shendurney	Thenmala	
20	Neduvathumuzhi	Konni	

ANALYSIS

The extent of damage is assessed in two ways, the number of plots raided (area of 10 sq. m) or the number of crops damaged. Their respective formulae are given below:

$$\text{i) Percentage of plots raided} = \frac{\text{Number of plots damaged}}{\text{Total number plots}} \times 100$$

$$\text{ii) Percentage of crop plants damaged} = \frac{\text{Number of plants damaged}}{\text{Total number of plants}} \times 100$$

RESULTS

Protection methods and crop damage

The protection methods employed in different locations sampled in Kerala could be broadly classified into five categories:

1. GU+OF = Guarding with Ordinary Fencing: Fencing by various materials combined with guarding
2. SP = Special Protection: Crackers are used to scare away the animals
3. STW = Stonewall Fencing: Walls built around cultivated areas
4. CHE = Chemicals: Chemical repellents
5. EF = Electric Fence: High voltage electric fencing around the cultivated area

The effectiveness of the methods employed varied according to the locations (Table 2). Electric fencing, which was observed only in the Northern Circle was the most effective in the region. The Southern Circle employed a variety of protection methods, of which special protection followed by chemical repellants were the most effective.

Wild boar raided the most (52.5%) in guarded areas with ordinary fence, followed by elephant (41%) (Table 3). Crop raiding by other species individually or in combination was less in guarded plots with ordinary fencing. Special protection method employed in the Southern circle was not effective against wild boar. Stonewall fence was recorded only in the High Range circle, where all the plots were damaged by gaur. In areas where chemical repellents were used, the percentage of plots damaged by wild boar was high (78%). In electric fenced areas, the percentage of plots damaged by elephant was high (55%) followed by an elephant and wild boar combination (31%).

Table 2: Percentage of raided plots under different protection methods

S. No	Circles	Protection methods					No. of plots laid
		GU+OF	SP	STW	CHE	EF	
1	Northern	37 (46.25)				29 (36.25)	80
2	Olavacode	49 (62.25)					80
3	Central	28 (35.00)			8 (10.00)		80
4	High Range	14 (17.5)		16 (20.00)			80
5	Southern	32 (40.00)	10 (12.5)		15 (18.75)		80
	Total	160	10	16	23	29	400

Figures in parentheses denote percentages

An attempt was made to analyse the effectiveness of various protection methods applied at locations on the periphery and in the enclosure (Table 4). The percentage of plots raided by wild animals was higher on the periphery (43%) compared to those in the enclosures (37%) in the locations guarded with ordinary fencing.

DISCUSSION

The highest numbers of plots damaged were in the periphery of the forest followed by the enclosure. The high incidence of crop raiding on the periphery, as well as in the enclosures, indicates greater risk and high probability of crop raiding in areas adjacent to wildlife habitat edges (Dudley *et al.* 1992).

Effectiveness of various control measures has been one of the important topics of debate in recent times. Control measures of long-term and short-term effects have been employed worldwide (Sukumar 1986; Schultz 1988; Santiapillai and Jackson 1990; Thouless and Sakwa 1995a; Bist 1996). The efficiency of the methods is reported to vary, depending on several factors including the raiding animal.

Protection methods prevalent in different locations in Kerala and their effectiveness vary only to a lesser extent. However, the efficiency of the methods varies considerably with the raiding animals. This necessitates the development of new, innovative, eco-friendly, socially acceptable and cost effective long term solutions which are effective against most of the crop raiders.

Crop Protection Methods used in Kerala

The farmers employ a variety of protection methods, which can be classified as follows:

1. **Guarding and Ordinary Fencing**: In 45 settlements, crops were guarded at night from machans or platforms on top of rocks or trees. Wild animals were scared off by noisily beating on metal tins, and by torchlight and fire. This method requires vigilance throughout the night. In most places, firewood or old tyres are used to light fires at night. Electric bulbs are also installed in the field. Dogs are used to detect and chase off wild animals, and to alert the guards.

Coloured cloth and plastic bags are tied to poles and scarecrows used in the field to scare off raiding animals. When the wind blows, the sound of the plastic bags scares the raiders away. Arecanut or palmyra sheaths are tied to the trees for the same purpose. Cacti are planted along the boundary of the crop field as deterrents. The field is surrounded with fences of thorny branches of bamboo,

Table 3: Percentage of plots raided under different protection methods by different wild animals

S. No.	Animals	Protection methods					Total
		GU+OF	SP	STW	CHE	EF	
1	Elephant	66 (41.25)				16 (55.17)	82 (34.45)
2	Gaur			16 (100)			16 (6.72)
3	Sambar	1 (0.63)			1 (4.35)		2 (0.84)
4	Wild Boar	84 (52.50)	10 (100)		18 (78.26)	4 (13.79)	116 (48.74)
5	Elephant + Wild Boar	5 (3.13)				9 (31.03)	14 (5.88)
6	Elephant + Bonnet macaque	1 (0.63)					1 (0.42)
7	Sambar + Wild Boar				1 (4.35)		1 (0.42)
8	Chital + Wild Boar				3 (13.04)		3 (1.26)
9	Wild Boar + Porcupine	3 (1.188)					3 (1.26)
	Total	160 (100)	10 (100)	16 (100)	23 (100)	29 (100)	238 (100)

Figures in parentheses denote percentages

Table 4: Percentage of plots raided by wild animals on the periphery and in the enclosure under different protection methods

S. No.	Protection methods	Plots damaged Enclosure n = 200	Plots damaged Periphery n = 200
1	Guarding + Ordinary fence	74 (37.00)	86 (43.00)
2	Special protection	10 (5.00)	-
3	Stone wall	7 (3.50)	9 (4.50)
4	Chemicals	10 (5.00)	13 (6.50)
5	Electric fence	10 (5.00)	19 (9.50)
	Total	111	127

Figures in parentheses denote percentages

Acacia, and *Zizyphus* to prevent the smaller mammals and cattle from getting in. Closely tied wooden poles act as a barrier to wild boar and deer. Such barriers are located in many places in Kerala. Four or six rows of metallic wires are stretched all along the boundary to keep out deer and wild boar. These are effective only to a certain extent as the animal may jump over the fence. Fences of 10-12 rows of barbed metallic wires are installed all along the boundaries of the field. The wire is fixed crosswise. This kind of fence was recorded in most places during the survey. The sound and light of crackers scare the animals away. Burning torches are thrown at the animal leading to injury, but this is not done at most places.

2. **Stone wall**: Only two settlements had stone walls to protect crops. The wall was built with rough-cut pieces of rock and stone, held together with cement, and was 1 m wide at the base, 0.5 m on top, and 2 m high. During the study period a brick wall measuring 0.5 m at the base, 0.25 m on top, and 1.5 m high was built in the Pallanad check post and Anakalpetti settlements of Marayur Range. There were several instances of gaur jumping over the brick wall in Marayur. Angle irons with barbed wire were often fixed on top all along the stone wall, to prevent gaur from scaling the wall. A stone wall cost about Rs. 50,000-75,000 / km, while a brick wall cost Rs. 40,000-50,000 / km.

In Kuppady of Sulthan Bathery range, a stone wall of about 3 km was built by the Forest Department all along the tar road to stop elephants from entering the settlements. In some places, especially in Peppara Wildlife Sanctuary, farmers had made rubble walls *c.* 1 m high and 0.5 m wide without cement to keep out smaller mammals, but it was not effective against elephants.

3. **Line cracker**: Line cracker is a special protection method recorded from four settlements during the study period. A metallic wire of small gauge is extended all around the field at a height of 0.5 m, and one end of this line is tied to a stone with crackers. When an animal touches the line, the device gets loose and the crackers hit another stone on the ground below the device, and explode. The sound alerts the farmer on guard and also deters the animal. The method is widely used throughout Kerala and is reported to be effective against most animals, especially elephant and wild boar.

4. **Chemicals**: In three settlements, the farmers were using chemicals for protection. The smell of pesticides, such as Forite and Furadon repels the animal away from the crop field. It is effective against wild boar, but was found effective for only a week in Karingayam Kavu of Chimmony Wildlife Sanctuary. In some places, naphthalene and phenol are used to repel elephants.

Kerosene or waste oil is poured along the possible entries of smaller animals, such as porcupine, black-naped hare and mouse deer. Kani tribes in Peppara Wildlife Sanctuary tie cloth soaked in kerosene to a pole and fix them in the field. Toilet or washing soap is kept in a coconut shell or tied to a stick and installed in the field. In the cold atmosphere, the soap gets wet and its fragrance helps to keep smaller mammals away from the field. However, when this method was tried in Perumalai in Marayur, the animals kept away from the field for only a few days, as they got used to the smell. Replacement after a short break had the same effect.

5. **Trenches**: Elephant proof trenches, 2 m deep, 3 m wide at the top and 1 m at the bottom have been dug in Wynaad and found to be effective against elephant, gaur and wild boar. Such trenches cost about Rs. 50,000 / km and require annual maintenance. Trenches are not feasible in areas with loose soil and high rainfall.

6. **Electric fence**: Electric fencing was recorded in only three settlements. The method is widely used the world over and is reported to be effective against most animals, depending on the number of wires used. The electric power fences are normally *c.* 150 cm high with 3 to 4 wires *c.* 30 cm apart. They require good maintenance, vegetation in contact with the wires has to be removed. Further, though the fence was reported effective against elephants, tuskers reportedly use their tusks or poles to break the wires. More often, the fence acts as a psychological barrier once the animal has felt a shock from one encounter. In Kerala, about 120 km of electric fences have been erected around settlements at various locations in Wynaad. Electric fences have also been erected in Neyyar and Peppara Wildlife Sanctuaries.

An evaluation of the methods used in Kerala is given in Table 5. Most methods are not suitable against all the animals and those effective against a single animal, are not necessarily cost effective. The selection of a method would depend on the site, raiding animal and funds available.

Table 5: Evaluation of crop protection methods in Kerala

Methods	Advantages	Disadvantages
Watchman (guarding at night from machans, huts on ground or rocks)	Immediate effect. Can be used in combination with ordinary fencing	High wages, animals, mainly elephant and gaur, become habituated and are dangerous for watchers
Sound making devices	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated
Lighting fires in the field using firewood, burning tyres or torches, and illumination with electric bulbs	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated
Olfactory (burnt chillies, toilet soap, smoke, repellents	Immediate effect. Can be used in combination with ordinary fencing, inexpensive	Animals become habituated in short duration
Barriers (thorn fence, ropes, spikes, barbed wire, wooden poles)	Easy to construct, very effective against small mammals	Expensive, may cause injury to the animals. Not very effective against larger animals.
Missiles (spears, arrows)	Deterrent, not usually fatal to animals	Expensive, may injure the animals, wounded animals become aggressive
Pet dogs	Alert the man on watch	Elephant may get aggressive, chase dog, and may turn out to be detrimental to man on watch
Unpalatable vegetation barriers (Cacti, *Hibiscus* sp., eucalyptus, etc.)	Easy to grow, less expensive	Not effective against all animals
Stone wall	Little maintenance required	Limited effect, material not easily available, very expensive
Trenches	Very effective	High cost of construction and maintenance. Elephant can refill ditch. Not advisable in high rainfall areas with loose sandy soil.
Electric fencing	Rapid construction, design can be easily changed, very effective	Periodic maintenance required, high cost

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WINTERING RECORDS, ECOLOGY AND BEHAVIOUR OF KASHMIR FLYCATCHER *FICEDULA SUBRUBRA* (HARTERT & STEINBACHER)[1]

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The Kashmir Flycatcher (*Ficedula subrubra)* is vulnerable and is a Red Data Book (RDB) species from the Indian subcontinent (BirdLife International 2001). It has been recorded sparingly in Nepal, Bhutan and Pakistan. While its wintering is confirmed in Sri Lanka, there have been very few records of its wintering in India and its status and distribution within Indian limits is not exactly known. Of the total 28 site records of this species from Indian limits, only two published records (Harrap and Redman 1989; Karthikeyan and Athreya 1992) go to prove its wintering in peninsular India. The rest are passage records from across India during migration.

We conducted this study during March 2001, and October 2001 to April 2002, in the Nilgiri Hills of Tamil Nadu. A total of 16 birds (9 males and 7 females) were recorded from 9 different sites above 2000 m elevation. The Kashmir Flycatcher holds a winter territory and prefers wattle (*Acacia* spp.) openings with good grass cover. It avoids forests with high tree density and canopy cover. Behaviour and ecological aspects are discussed, based on our observations on eight birds, during the two wintering seasons. Habitat degradation and disturbance appear to be serious threats to the long-term survival of this bird. There is an urgent need to carry out status surveys in the wintering and breeding areas and also to study its ecology and biology to aid conservation and management.

Key words: Wintering records, ecology, Kashmir Flycatcher, *Ficedula subrubra*, Nilgiris, behaviour

INTRODUCTION

The Kashmir Flycatcher is one of the 35 species of Muscicapinae reported from the Indian subcontinent (Manakadan and Pittie 2001). There was a great deal of uncertainty regarding the taxonomic position of the Kashmir Flycatcher *Muscicapa subrubra*. It was generally confused with the Red-throated Flycatcher *Ficedula parva*, until it was finally judged "evidently as a separate species on the basis of plumage characteristics, moult sequence and wing formula" (BirdLife International 2001).

It breeds in the northwest Himalaya and Pir Panjal Range (Ali and Ripley 1987) and has been reported very common in Overa Wildlife Sanctuary in Jammu and Kashmir (Jamdar 1987). The Kashmir Flycatcher has a very restricted distribution in northern India and in some parts of Pakistan, occurring as a summer breeding visitor to the side valleys of Kashmir and in the Pir Panjal range (Bates and Lowther 1952; Henry 1955; Roberts 1992). Additionally, the species has been recorded from 37 sites in Sri Lanka, 5 in Pakistan, 7 in Nepal, only 1 in Bhutan (See BirdLife International 2001).

However, very little is known about its wintering status and distribution in Indian limits. It is believed that virtually the entire population winters in Sri Lanka from October to March above 750 m in gardens, tea estates and on forest edges, and scarce passage migrants are seen over Peninsular India (Ali and Ripley 1987). It has been reported from 28 sites in India since the 19th Century (BirdLife International 2001). Of these, only two published records prove its wintering in Nilgiri hills i.e. Harrap and Redman (1989) based on sightings of four males from the Nilgiris (two in Ooty and two near Avalanche road in February 1985), and Karthikeyan and Athreya (1992) based on a single male record from Muthorai in December 1990. The rest are either spring and passage records from Andhra Pradesh (Currie 1919), Maharashtra (Baker 1922-1930), Bihar (Inglis 1906), Madhya Pradesh (Majumdar 1984), Himachal Pradesh (Whistler 1926), Point Calimere Wildlife Sanctuary, Tamil Nadu (Jamdar 1987), Punjab (Robson 1999; Kalsi *et al.* 2001), and Chandigarh (Rajiv Kalsi *pers. comm.*), and some records from breeding areas in Jammu and Kashmir.

We present our observations on ecology and behaviour of four pairs, two each during two wintering seasons. We also report the results of our survey during October 2001 to April 2002 in the Nilgiri hills. A total of 16 birds (nine males, seven females) were recorded from nine different sites during our study. There is an urgent need to confirm the wintering status and also to study the ecology and behaviour to aid the conservation and management of this species.

STUDY AREA

The present study was conducted in the upper plateau of the Nilgiris (11° 10' and 10° 30' N; 76° 25' and 77° 00' E) in the state of Tamil Nadu, India. The plateau is bordered by Kerala on the west, Karnataka to the north and Coimbatore district to southeast (Fig. 1). The Nilgiris (1,580 sq. km) occupy the highest and westernmost part of Tamil Nadu State. The study area is part of the Nilgiri Biosphere Reserve, within the Western Ghats (Zone 5) in the biogeographic classification of Rodgers and Panwar (1988).

Legris (1969), Blasco (1970) and Lengerke (1977) have given a great deal of information on the weather and the climate of the Nilgiris. The area receives both southwest and northeast monsoons. There is considerable local variation in average annual rainfall in the study area, with Mukurthi National Park and surrounding areas receiving up to 5,600 mm per year. Most of the forested area in the Nilgiris is under plantation, with very little natural montane wet temperate forests locally known as *shola*. Plantations constitute mainly Wattle (*Acacia* sp.), *Eucalyptus* sp., *Pinus* sp., *Cupressus* sp., Cinchona (*Cinchona cinchona*), Coffee (*Coffea arabica*), and tea (*Camellia sinensis*). Wattle forms the most dominant introduced species, followed by Eucalyptus and Pine.

METHODOLOGY

Observations in March 2001 (first wintering season) were made only on two pairs sighted in the Avalanche Reserve Forests area of the Nilgiris South Division. However, during the second wintering season (October 2001 to April 2002), we surveyed all the three Forest Divisions, covering most of the Nilgiris Upper Plateau.

Survey methods

During the first wintering season, we acquainted ourselves with the call types of the Kashmir Flycatcher. In the second wintering season, survey was carried out on a weekly basis in the Nilgiris above 1,800 m elevations, up to the highest peak (Dodabetta 2,634 m). On each survey day, a different area was visited. We first tried to detect the species mainly through calls, and then followed the call till we located the bird. Sampling was stratified according to vegetation types i.e., Wattle, Eucalyptus and Pine and *Shola*. We made an effort to keep to the edges of streams and water sources and nearby areas in each habitat type.

Habitat sampling

We laid 0.05 ha (r = 12.6 m) circular plots for habitat sampling in the sites where we recorded the bird. At some sites where birds were seen regularly during the study, more than one plot was taken. Similar plots (one each) were laid in the sites that were thoroughly searched, but no Kashmir Flycatcher was seen. Habitat sampling methods by Muller-Dombois and Ellenberg (1974) and Bibby *et al.* (1992) were followed. At each plot, habitat parameters, such as tree count,

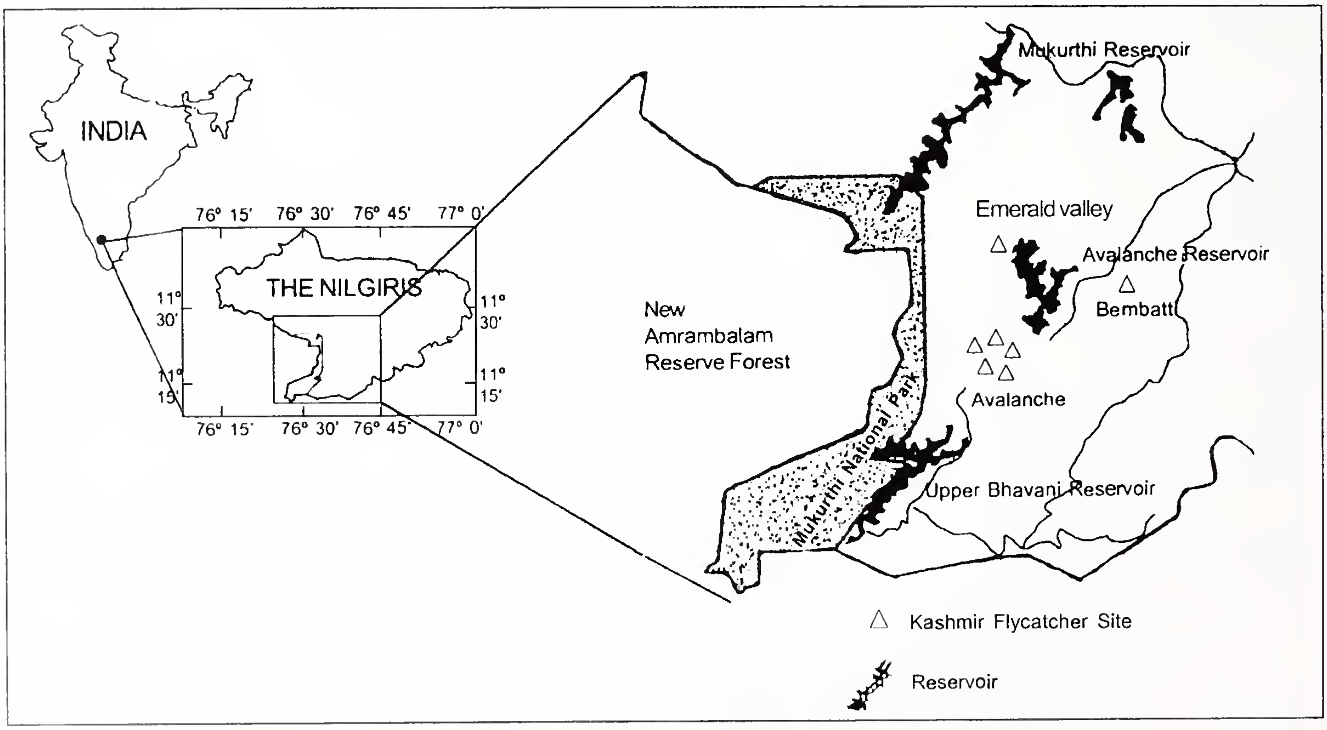

Fig. 1: Kashmir Flycatcher sightings during 2001-2002

Table 1: Kashmir Flycatcher sightings in March 2001 and October 2001 to April 2002 in the Nilgiris

Site	Date	Habitat	Number	Male	Female	Locality
First winter season						
1	09/03/01	Wattle edge	2	1	1	Avalanche
2	10/03/01	Wattle edge	2	1	1	Avalanche
Second winter season						
3	08/10/01	Wattle edge	2	1	1	Avalanche
4	25/11/01	Wattle edge	2	1	1	Emerald Valley
5	07/12/01	Wattle edge	2	1	1	Avalanche
6	23/01/02	Wattle edge	2	1	1	Avalanche Power House
7	22/03/02	Tea/wattle	1	1	0	Bambatty
8	24/03/02	Wattle	2	1	1	Avalanche
9	27/03/02	Pinus edge	1	1	0	Ramaya road
Total			16	9	7	

canopy cover, canopy height, tree species, shrub count, shrub height, shrub cover, grass cover, grass height, litter cover and litter depth were recorded. All trees or shrubs in a plot were counted by species. Canopy height was estimated visually. Shrubs were sampled in 4 x 4 m plots placed randomly in the circular plot. Data on ground cover was estimated by placing 1 x 1 m quadrats placed in these plots. Litter height was measured with a scale at the four corners of each 1 x 1 m quadrat.

We also recorded other parameters, such as distance to road, the nearest stream, the neighbouring village or habitation. Land use practices with respect to cutting, lopping and grazing pressure were also recorded.

Ecology and Behaviour

Observations were carried out from sunrise to sunset on four birds (2 pairs) on Sites 1 and 2 during March 2001, and two pairs on Sites 3 and 6 during the second wintering season. Food and feeding methods, calls and vocalization, roosting behaviour, inter-specific interactions, territoriality and daily movements were recorded.

Analysis

Principal Component Analysis (PCA) was performed to identify the patterns of covariation among the habitat parameters, using SPSS 7.5. It reduces a large number of covarying variables into a smaller number of orthogonal components that account for maximum variation in the data (Manly 1986). Factors with Eigen values below 1 were excluded. The extracted components were then interpreted through factor loading associated with the original variables. The occurrence of birds was plotted against the first two components (PC 1 and PC 2) extracted by PCA.

A natural log transformation ensured that all habitat variables were normally distributed. The categorical variables, namely presence or absence of lopping, grazing pressure and presence of a dry/flowing stream were not included in PCA. The categorical variables were compared between the sites with and without Kashmir Flycatcher sightings, using Fisher's Exact Probability Test.

RESULTS

Survey results

Of the total 16 birds sighted during this study, four birds (2 pairs) were sighted at 2 different sites (Site 1 and 2) in March 2001 (first wintering season). Both these sites were in the Avalanche Reserve forest near the reservoir. However, during our survey between October 2001 and April 2002, we found 12 birds (7 males, 5 females) at 7 sites (Site 4-9) (Table 1). All the birds were sighted in Wattle plantations, except a single male on the edge of a tea plantation and cultivated area (Site 7) and another male sighted at the edge of Pine (*Pinus patula*) and Scotch Broom (*Cytisus scoparius*) forests (Site 9). The details of the sightings made in the two wintering seasons are given in Table 1.

In addition to the sites listed in Table 1, we surveyed Mukurthi National Park, Dodabetta, Upper Bhavani, Ramaya Road, Kundah, Pykara, Pandiar, Cairn Hill Reserve, Snowdon, Bambatty, Emerald Valley, Katkopai, Bikkaty area forests of the Nilgiris South, North and Wildlife Divisions (Fig. 1), but no Kashmir Flycatcher could be seen.

Habitat

The results of the first four principal components (PC) extracted by the PCA with Eigen value greater than 1 are summarised in Table 2. The first four factors (PC 1 to PC 4) accounted for 73.3% of the variation. PC 1 alone accounted for 36% and PC 2 for 17.4%. PC 1 represented increasing tree number, canopy height, canopy cover as well as distance from the nearest settlement and road, and decreasing grass height and cover. PC 2 represents increasing shrub cover and decreasing litter cover and depth. PC 3 represented increasing litter depth. High values of PC 4 represent increasing shrub height and litter depth. Factor loadings of different habitat variables on four major components (PC 1 to PC 4) extracted during PCA are tabulated in Table 2.

The habitat plots with and without Kashmir Flycatcher were plotted on a scatter plot of their principal component (PC 1 and PC 2) scores (Fig. 2). Although overlap occurred, the plot with and without flycatcher sightings occupied distinct regions in the factor space, separating along PC 1, while PC 2 had little effect on the occurrence of birds. Thus, the occurrence of birds seemed to be associated mainly with the decreasing tree cover and increasing grass cover. As is clear from Fig. 2, in the areas with a given tree density, sightings were all on plots with greater grass cover.

A scatter plot of the plots with and without Kashmir Flycatcher sightings along the number of trees and extent of grass cover shows that most of the sightings were in the plots having 10 to 60 trees per plot and 30-60% grass cover. The chances of sightings clearly decrease as the tree density and grass cover increases or decreases from this range (Fig. 3).

Fishers Exact Probability Test indicates that 90% of the plots with flycatcher sightings had grazing pressure (Fp > 0.002), but the presence of flowing or dry stream (Fp = 0.127), or lopping (F = 0.065) did not differ significantly between the plots with or without sightings. Comparison of categorical variables (presence or absence of lopping, grazing and presence of a dry/flowing stream) between the sites with and without Kashmir flycatcher sightings using Fisher's Exact Probability Test is summarized in Table 3.

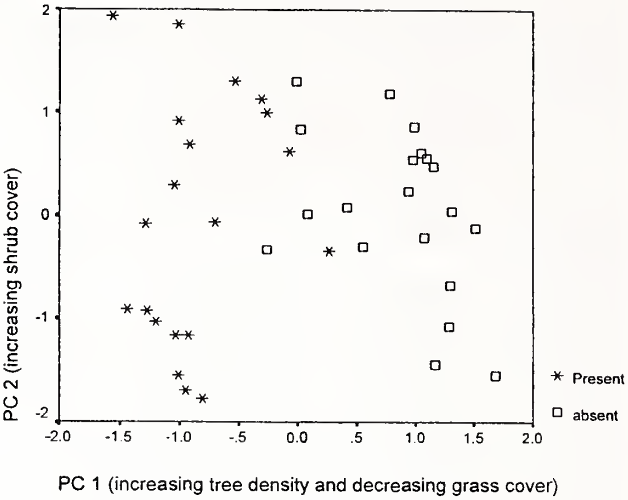

Fig. 2: Occurrence of Kashmir Flycatcher plotted with reference to two components (PC1 and PC2) identified by Principal Component Analysis

Ecology and Behaviour

i) **Food and Feeding**: The Kashmir Flycatcher is insectivorous (Henry 1955). Food mostly constituted insects, including small butterflies, moths, grubs, earthworms, larvae and caterpillars. The birds were often seen coming down to

Table 2: Factors loadings of different habitat variables on four major components extracted in Principal Component Analysis

	Components			
Parameters	PC1	PC2	PC3	PC4
Canopy height	0.617	0.119	-0.489	0.422
Canopy cover	0.692	-5.928E-03	0.401	-0.100
Grass cover	-0.953	3.449E-02	4.698E-02	-3.544E-02
Grass height	-0.755	2.690E-02	0.272	-3.950E-02
Litter cover	0.571	-0.579	0.311	0.280
Litter depth	0.0368	-0.280	0.516	0.588
Dist. from road	0.0672	0.250	-0.285	-7.879E-02
Dist. From settlement	0.0613	0.332	0.225	-0.393
No. of shrubs	-7.78E-02	0.835	0.374	2.019E-02
Shrub cover	0.284	0.856	9.527E-03	0.220
Shrub height	-0.554	0.442	3.496E-03	0.568
Distance from stream	0.425	-9.046E-03	-0.467	7.059E-02
No. of trees	0.694	0.170	0.273	-0.162
Eigen Value	4.68	2.28	1.40	1.17
% variation	36.04	17.36	10.80	9.06
Cumulative	36.04	53.40	64.21	73.27

Table 3: Comparison of categorical variables between the sites with and without Kashmir Flycatcher sightings using Fisher's Exact Probability Test

			Total	Stream (Dry/Flowing)		Lopping		Grazing	
				0	1	0	1	0	1
Bird		count	20	2	18	8	12	12	8
	0	count%	100	10	90	40	60	60	40
		count	20	7	13	2	18	2	18
	1	count%	100	35	65	10	90	10	90
Total		count	40	9	31	10	30	14	26
		count%	100	22	77	25	75	35	65

0 = plots with no Kashmir Flycatcher
1 = plots with Kashmir Flycatcher

buffalo dung and digging out insects from the heap. Size of the food items varied from a few millimetres to nearly 12 cm (earthworm). They usually fed very close to the ground, about 1-2 m.

The feeding method is typical flycatcher-like: taking off to catch an insect and returning with the prey to the same or nearby perch for feeding. However, at times the birds come to the ground unlike most other flycatchers, spend some time feeding or hopping around collecting the prey, before returning to the perch. Similar behaviour has been noted by Henry (1955), and Banks and Banks (1980).

The Kashmir Flycatcher feeds more actively in the morning and evening hours, though it has been recorded feeding throughout the day. At mid-day, the bird takes a longer duration (22 minutes (mean) n = 67) between two feeding bouts, unlike the morning and evening (5 minutes (mean) n = 34) when it feeds frequently, accompanied with other activities, such as calling, preening and vigilance.

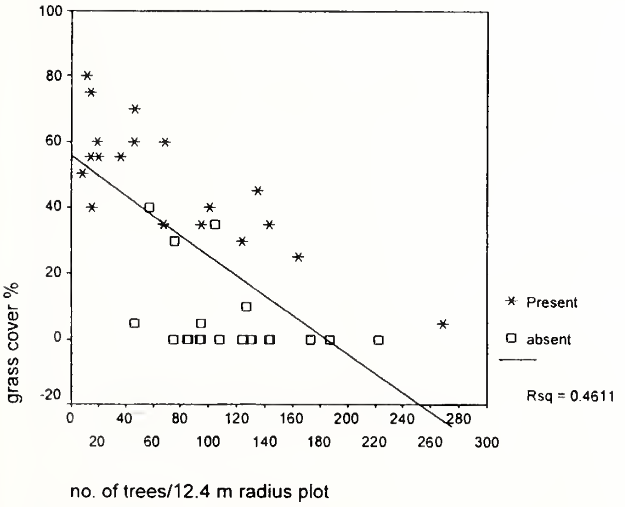

Fig. 3: Occurrence of Kashmir Flycatcher plotted with reference to tree density and grass cover

The birds at Site 3 (second wintering season) came almost to the middle of the road to catch insects from the litter. They would usually perch very close to the branches on the road bank and sally from there.

ii) **Winter territory**: Birds generally, including most species of the flycatcher group, pair in the breeding season only, but the Kashmir Flycatcher maintained a pair bond during the wintering period also. Most of the birds sighted were in pairs, except two, which were solitary (Table 1). Of the total 7 pairs sighted during the study, observations were carried out on four pairs. During the entire period of observation, all these pairs advertised their territory by calling frequently, though territorial disputes were not very frequent. A site wise summary of the days these four pairs were recorded in their territories is given in Table 4.

The difference in the number of days the pairs were seen holding territories is because in 2001, our study started in March. Also, in the second wintering season, the variation is because the pairs were sighted on different dates. However, it is important to note that there is hardly any difference in the dates when the pairs were sighted last in both the years. Both the sexes were parochial and seen in their territories throughout the winter.

iii) **Interaction with other birds**: Since the beginning of our observations, the only species that we found aggressively chasing Kashmir Flycatcher was the Pied Bushchat (*Saxicola*

Table 4: Sitewise detail of the days Kashmir Flycatcher pairs held their territories

Site No	First seen	Last seen	Days
1	09/03/01	27/03/01	19
2	07/03/01	27/03/01	21
3	08/10/01	04/04/02	179
6	23/01/02	04/04/02	72

caprata). During the morning and evening hours, when both the species were busy feeding, they appeared more hostile to each other. The Pied Bushchat chased the Kashmir Flycatcher away from the area. Nilgiri Flycatcher (*Eumyias albicaudata*) was seen chasing the Kashmir Flycatcher (n = 5) in March and April 2002; however, during the earlier months of wintering (October-November), both species were seen feeding closer, apparently without competition.

The Kashmir Flycatcher was found feeding very close to winter visitors, such as the Greenish Warbler (*Phylloscopus trochiloides*) and Tickell's Leaf Warbler (*Phylloscopus affinis*) and the resident species Great Tit (*Parus major*) without any competition.

Another important change that we recorded in the species' reaction to human presence near their territory was that, up to the end of February, the birds were not shy and allowed us to make close observations (from 10-15 m), but after March till the birds left, they became very shy and would be disturbed even from a considerable distance (20-30 m). They would become restless, stop calling and would go high up in the trees.

iv) **Diurnal activities and movements**: Most of their activities were centred near the territory. The female would remain almost throughout the day in the territory and would go for feeding up to 200-300 m from the roost site. However, the male would leave the territory between 0930 to 1000 hrs (n = 20) and would forage up to 500 m from the main territory. He would return to the territory once or twice to reinforce the pair bond, and on his arrival the pair would call *whip whip whip* loudly for some time.

The male spends 25-165 min before leaving the territory to resume its foraging elsewhere. But, he would return around 1820 hrs and immediately after his arrival, both male and female would again start calling. After feeding together for about 5 minutes, both would fly away and then come back to roost at the same site after sunset (1845 h), when nearly all other species had already settled.

v) **Site fidelity**: Site 2 (first winter) and Site 6 (second winter) were at exactly the same spot in Avalanche at the edge of a Wattle plantation. Both the years, the pairs were seen holding the territory near the same *Ternstroemia japonica* tree. Perhaps the flycatchers have site fidelity, but this can only be confirmed by colour banding the pairs in the wintering grounds and monitoring their arrival next season.

vi) **Calls and vocalization**: The bird is very vocal, and keeps calling most of the day. It frequently utters a single note whistle *whip whip whip whip*... resembling the Pied Bushchat (*Saxicola caprata*) call in form when the Bushchat is agitated. Henry (1955) has also described this particular call in the wintering areas of Kashmir Flycatcher. However, the call that Ali and Ripley (1987) described (a curious little creaking rattle *chack* being uttered while flitting about) was never heard. Instead, a call sounding *chit..rrrr..rr chit* is uttered as a rule when the bird flits or loops from one branch to another or descends to the ground to feed. This call is accompanied by a flicking of the wings and the tail. A two-component call *chrit chrit* or a single *chrit* is often heard associated with the *Chit..rrrr..rr chit* call.

The *chit..rrrr..rr chit or chrit chrit* is uttered less frequently (6-7 times per minute) than the *whip whip whip* call, which is uttered almost constantly at a single call per second. The *whip whip* call can be heard near the territory during most of the day, at short intervals. However, the calling frequency drops abruptly to a single call in 2-3 minutes before the roosting.

Complex call during resting: Apart from the two distinct and identifiable calls, the Kashmir Flycatcher utters another unique low tone call while resting during the daytime between feeding bouts. This call sounds like a combination of the calls of a Ground Shrew (*Suncus murinus*) "*seek seek seek*", Common Myna (*Acridotheres tristis*) "*kew kew kreew-kreew-Kreew*", and a House Sparrow (*Passer domesticus*) "*cheer cheer cheer*", all uttered in sequence. While making this complex call, the bird holds its beak up vertically and the throat bulges out. The call cannot be heard from a distance of more than 5 m.

vii) **Roosting Behaviour**: One pair in March 2001 and two pairs from October 2001 to April 2002 were regularly observed for roosting behaviour. The flycatcher used the same patch for roosting throughout the winter and followed a strict time schedule. Roosting trees were in their territories, where most of their diurnal activities were confined (usually a small part of a plantation in the transmission line openings). Though the females remained for most of the time in the same small patch, before settling to roost, the pair would go away together from the site for about 20-25 minutes to the nearby stands of plantation, take a different route and silently come back to the roosting site. The height at which the species roosts is markedly different from that of most of its diurnal activities. Birds were seen roosting at more than 8 m, near the crown of wattle or thickly foliaged branches of Eucalyptus.

Threats in the Nilgiris

Clearly there is no threat from poaching or killing for this tiny bird, but habitat changes and anthropogenic pressure on its wintering quarter in the Nilgiris are serious threats that may have already affected the species' existence and use of this area as a regular wintering ground in future. Habitat degradation and loss is the key threat in almost all the area, namely Kashmir, Sri Lanka and Nilgiris. Though quantifiable data was not collected, we summarize the main threats to species in the Nilgiris based on our observations:

A) **Unsafe habitat**: Historically, the bird might have been using the edges and openings in the *shola* in the Nilgiris Upper Plateau, as there were no plantations earlier. Most of the plantations are not more than four to five decades old. Wattle, Pine and a variety of other plantations brought a sudden change in the Nilgiri vegetation. Though they are not its original habitat, the Kashmir Flycatcher seems to have adapted fairly to Wattle plantations. As cited in Table 1, almost all the birds were recorded in Wattle. Despite being within range forests and protected areas, the plantations have low value owing to poor timber quality or economic returns. Thus, the plantation habitat is under a variety of threats, such as clear felling, illegal cutting or lopping by the surrounding villages and others.

B) **Uncontrolled firewood collection and grazing**: The villagers dwelling around most of the Kashmir Flycatcher sites are totally dependent on plantations for fuelwood, thus mounting pressure on the already degraded habitat. The Kashmir Flycatcher seems to prefer Wattle patches with wide openings lined with dead branches and twigs that serve as its perch for flycatching. The regular removal of such dead and fallen trees, and branches by the villagers affects the microhabitat of the species. Herds of feral and domestic buffaloes were seen near Kashmir Flycatcher wintering sites. These herds ram into the plantations and birds were seen getting scared, perched high in the trees and calling aloud in alarm or flying across to other patches of plantation.

C) **Clear felling of privately owned plantations**: Some of the privately owned Wattle plantations near the Flycatcher sites have been clear felled by private owners during the study period. It is important to note that these plantations have proved to be the home to the species. Any move to clear fell such plantations (in privately owned lands or Reserve Forest) should take into consideration the impact on the wintering population of Kashmir Flycatcher in the Nilgiris.

DISCUSSION

Most ornithologists are of the opinion that almost the entire population of Kashmir Flycatcher winters in Sri Lanka, with a small population (recently discovered) wintering in the Nilgiris. Though Harrap and Redman (1989), Karthikeyan and Athreya (1992), Robertson (1990) and Robson (1985) reported the Nilgiris as wintering ground for the Kashmir Flycatcher, all of them were based on one or two sight records during winter. Also, Baker (1922-1930) gave its distribution as extending from the Afghan boundary and Gilgit, but there are no specimens or records from these places (Roberts 1992), nor does it breed around Simla (Himachal Pradesh) or Garhwal (Uttaranchal) in India, as he claimed.

Our sightings of 16 birds are more than all the earlier records of the species from peninsular India during the past 83 years, since Currie (1919) reported it from Secunderabad. This is proof that the Nilgiris are a regular wintering ground for this flycatcher. Although data are not available on the status of the populations in the breeding or wintering area, the species may be declining in both the grounds on account of recent habitat alterations. Over the years, population has declined in Sri Lanka (Collar *et al.* 2002).

Comparisons of PC 1 and PC 2 scores for sites with and without sightings indicate that the Kashmir Flycatcher selects open areas with more grass cover and low shrubs, and avoids areas with higher tree density. Wattle plantations with openings created by transmission lines provide such a habitat, but such areas generally have greater grazing and lopping pressure also. *Sholas* are generally well protected and have high tree density and canopy cover. But, the species avoids *sholas* and seems very comfortably adjusted in the Wattle plantation openings and edges. Competition with the resident species may also force the Kashmir Flycatcher to go for such marginal and disturbed habitats.

Association of species with forest having adequate openings and considerably good grass cover (that is usually grazed) rather than thick *sholas* (having minimum ground cover) may be the reason for significant differences in the plots with and without sightings.

Though the species remains in pairs, at two sites we saw single males. It may be that the birds were feeding apart during the day, when they were sighted, and both most likely had a mate feeding nearby. Females remained in their territory throughout the day, thus leaving the site before roosting and following another route to reach the regular roosting site silently, maybe an anti-predation strategy.

Feeding without aggression with species such as the Grey Tit, Greenish Warbler and the Tickell's Leaf Warbler may be because of resource partitioning or differences in mode of feeding and prey. There seems to be no apparent shortage of resource, but aggression towards and getting chased by species, such as Nilgiri Flycatcher and Pied Bushchat with the onset of the breeding season may be because of similarity in the mode of resource exploitation and food. The Nilgiri Flycatcher starts singing and breeding in mid-March and it was only during this time that it became hostile to the Kashmir Flycatcher. Interestingly, this hostile behaviour is recorded at a time when all birds are in need of more energy. This factor may be playing a considerable role in forcing the return migration.

Whip whip whip... and *Chrit..rrr..chrit* calls were very commonly heard up to a considerable distance from the territory. These calls did not resemble those of any other species of flycatchers in the Nilgiris, making it easier to detect the Kashmir Flycatcher during the surveys. During evening, the bird called less, which may be because the bird feeds more intensively during pre-roosting time. Complex calls heard may be because of its fondness for mimicry. Though these calls were very low in tone, the posture of the bird (beak raised vertically and throat bulging) indicated a huge effort in uttering such calls.

The Kashmir Flycatcher is the only flycatcher found in the study area that holds a winter territory. Becoming more vigilant and sensitive to human presence in their territory before the return migration may be their protective strategies.

Most of the Kashmir Flycatcher sightings were in Avalanche Reserve Forest area, which is facing heavy anthropogenic pressure. These forests should be protected and disturbance should be minimised, mainly in the wintering season. Clear felling of the private plantations should be minimized; otherwise it may affect the wintering population of this scarce bird species.

Though it is generally thought that a very small population winters in the Nilgiri Hills, we suspect there is possibility of a good wintering population of Kashmir Flycatcher in the Nilgiris Upper Plateau, though it is not comparable to Sri Lanka. A concerted effort is needed to determine the status of the wintering population in peninsular India, mainly in the Nilgiri Hills.

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DESCRIPTIONS OF NEW LEPIDOPTERA FROM THE KUMAON HIMALAYA[1]

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Comostola hauensteini sp. nov., *Neptis miah varshneyi* ssp. nov., *Anambulyx elwesi kitchingi* ssp. nov., *Hypochrosis hyadaria* forma *stigmata* nov., the Wet Season Form male and both seasonal forms of the hitherto undescribed female of *Garaeus parva discolor* Warren are described from the Kumaon Himalaya.

Key words: new species, new subspecies, Lepidoptera, Kumaon, Himalaya

INTRODUCTION

Kumaon consists of a section of the Himalayan range west of Nepal. The specimens discussed in this paper were all taken in the Bhimtal valley in Nainital district in Uttaranchal, where the main study site is located at Jones Estate (1,500 m above msl; 29° 20' 41" N, 79° 36' 17" E) and the adjoining Sattal valley (1,200 m) and Ranibagh valley (700 m, Bhujiaghat), where some specimens of *Neptis miah* Moore were taken.

All specimens were taken by the author and are in the author's collection.

1. *Neptis miah* Moore (Nymphalidae: Limenitidinae)

Neptis miah has been reported from Central Nepal eastward along the Himalaya, through western China south to Borneo, Mentawi Islands, Java and Bali. Along this range, Eliot (1969) recognized seven geographical races. Within the Indian sub-region, two races are recognized, the nominate race known from central Nepal to the hills of northeast India (described from a male from Darjeeling) and the race *nolana* Druce, recorded from Myanmar to Thailand (described from a female from Chantaboon, Thailand).

The hitherto unreported population of *miah* in the Kumaon Himalaya bears a strong resemblance to *Lasippa viraja* Moore, with which it appears to have been confused in the past (Hannyngton 1910; Evans 1932; Wynter-Blyth 1957). The following is a description of this population.

Neptis miah varshneyi ssp. nov.

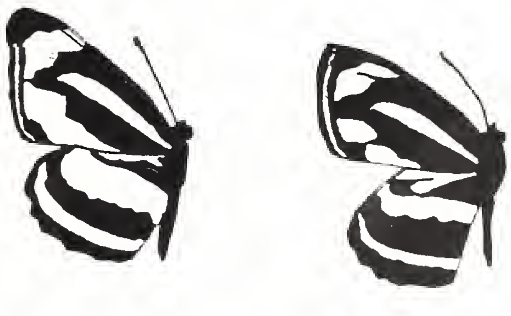
Material Examined: Holotype: Male 21.v.1988 Bhimtal. Forewing Length: 25 mm. Expanse 54 mm.
Paratypes: 36 exs.: 14.iv.1982 Bhimtal; 1.v.1982 Bhimtal ♂; 28.iv.1984 Bhimtal ♂; 30.iv.1982 Bhimtal ♂; 14.v.1982 Bhimtal ♂; 7.iv.1985 Bhimtal ♂; 30.iv.1992 Sattal ♂; 1.v.1992 Sattal ♂; 2.v.1992 Sattal x 4; 4.v.1992 Sattal x 3 ♂; 5.v.1992 Bhimtal ♂; 21.v.1992 Sattal ♀; 22.v.1992 Sattal; 2.vi.1992 Bhimtal ♀; 3.vi.1992 Sattal ♀; 4.vi.1992 Bhimtal ♀; 8.x.1992 Sattal x 2; 28.iii.1994 Bhimtal ♀; 18.iv.2003 Bhimtal ♂; 5.v.2003 Bhujiaghat x 2; 2.vi.2003 Bhujiaghat ♀; 4.vi.2003 Bhujiaghat; 7.vi.2003 Bhujiaghat ♂; 11.iv.2004 Bhimtal ♂; 16.iv.2004 Bhimtal ♀; 16.iv.2004 Bhimtal ♂; 18.iv.2004 Bhimtal ♂; 22.iv.2004 Bhimtal ♀; 17.v.2004 Bhujiaghat ♀.
Forewing Length: 26-30 mm; Expanse: 56-64 mm.

Diagnosis: Both sexes with eyes brown; head, thorax and abdomen dorsally black, ventrally pale greyish. Legs pale greyish. *Recto* surface of wings black with orange yellow markings, which are not sharply defined. On forewing the upper margin of cell streak with a medial indentation in some individuals. Postmedial spots in interspaces 1 and 2 conjoined and extend into interspace 3, more or less meeting lower end of subapical series at vein 4. The erect submarginal orange yellow line usually not prominent. Apical cilia white.

Hindwing *recto* with relatively broad discal line. Postmedial band always extends into interspace 6. Submarginal line faintly marked, almost obsolete in some individuals (Fig. 1).

On *verso* surface, markings as in nominate race, but pale bands correspondingly broader and pale yellow, especially postdiscal spots in interspaces 1 and 2 on forewing.

Comparison with nominate subspecies: The subspecies *varshneyi* may be distinguished from the nominate race by the broader orange yellow markings on the wings, which are about 25% wider than nominate *miah*; the conjoined spots in interspaces 1 and 2 on the forewing recto which are not



varshneyi *miah*

Fig. 1: *Recto* surface of holotype of *Neptis miah varshneyi* ssp. n. and *N. miah miah*

separated by a black vein; and the pale markings on the verso surface, which are yellowish, not whitish. In *miah*, the non-lilac pale markings on the *verso* surface vary from off-white to white on both wings, the discal band on the hindwing being pure, almost shining white.

Remarks: On the basis of the type series, ssp. *varshneyi* is a little larger than the nominate race which, according to Evans (1932), has a wingspan of 45 to 60 mm. Atkinson (1882) and Hannyngton (1910) did not record *miah* from Kumaon, but Hannyngton recorded *L. viraja* as not rare. I am unaware of any extant specimen of *viraja* from Kumaon. In fact, *viraja* has not been recorded from Nepal either (Bailey 1951; Smith 1989,1993), though a specimen of *viraja* has been figured as *miah* by Smith (1993), according to the late J.N. Eliot (*in litt.*). Therefore, it seems likely that the *viraja* recorded from Kumaon was the local race of *miah*, which is described here. Evans (1932) and Wynter-Blyth (1957) appear to have reported *miah* erroneously as *viraja* from Kumaon.

N. miah varshneyi is not rare in the Kumaon Himalaya, where it has been recorded in the outermost range between 700 and 1,500 m above msl in forests of Himalayan oak (*Quercus leucotrichophora* A. Camus and *Q. glauca* Thunb.) and Sal (*Shorea robusta* Gaertn.). The flight is weak, very like *Pantoporia hordonia* (Stoll) or *P. sandaka* (Butler), although *miah* may be distinguished by its relatively larger wingspan. Individuals do not stay in one place for long.

According to Smith (1989), the nominate race of *miah* is not common at low elevation in Nepal, where he has recorded it up to 762 m (2,500 feet) above msl. However, of the two specimens recorded by Bailey (1951), one was collected at Bhimpedi at 610 m (2,000 feet) in October and the other at Kathmandu at 1372 m (4,500 feet) in May. In Kumaon, it has not been recorded below 1,200 m, although it probably occurs at low elevation in areas not surveyed so far.

In Kumaon, there are two annual broods, the first on the wing from mid-April to the end of June and the second through October to mid-November. There appears to be no seasonal variation between these broods, although according to Smith (1989), this butterfly is on the wing during the southwest monsoon months from July to September, in addition to the summer and autumn generations in Nepal. In the event that ssp. *varshneyi* has an additional generation on the wing during the monsoon, seasonal variation similar to the nominate race may occur.

The autumn generation is comprised of fewer individuals than the summer generation in Kumaon.

The subspecies is dedicated to Dr. R.K. Varshney, formerly of the Zoological Survey of India.

2. *Comostola hauensteini* sp. nov. (Geometridae: Geometrinae)

The genus *Comostola* Meyrick is largely Indo-Australian with two or three species in the Palaearctic Region. The genus has been treated comprehensively by Seitz (1908-1928; 1954). Besides the wing pattern and bright colours, the genus is distinguished by the unusual shape of the discocellular veins, which are similar to *Berta* Walker.

The genus is divided into two sections. The typical section has a straight forewing margin. The hindwing is slightly angled but never tailed at vein 4 and the pattern is similar to *Comostolopsis* Warren; the second section has rounder wings with a characteristic pattern. The present species belongs to the typical section.

Material examined: Holotype: Male 11.viii.1997. Bhimtal.
Forewing Length: 11 mm. Expanse 24 mm.
Paratype: Female 27.ix.1999. Bhimtal.
Forewing Length: 13 mm. Expanse 28 mm.

Diagnosis: Vertex of head green. Frons and palpi white. Antennae of male pale brown, bipectinate to two-thirds the length, the rami long. Collar white. Thorax pale green, abdomen with first segment dorsally green. Remainder of abdomen shining white. Legs white.

Forewing *recto* with the costa prominently white and unmarked. Ground colour of wing pale green with a white ringed rust-coloured spot on the discocellulars. An incomplete and very indistinct antemedial series of creamy spots, the two above the dorsum discernable. Postmedial series of faint creamy spots on the veins, not reaching the costa.

Hindwing *recto* pale green, with a white-ringed, rust-coloured spot on the discocellulars. Postmedial series of creamy spots obscure.

Both wings with a marginal rust-coloured line. Cilia white.

Verso surface shining white with a rust coloured spot on the discocellulars of each wing. Dorsum of both wings with a fringe of long green hair.

Female larger than male, antennae simple. Palpi much longer than in male, the second joint reaching above the head (Fig. 3). Both sexes with a pair of tibial spurs on hindleg.

Remarks: *Comostola hauensteini* can be immediately distinguished from other known members of the genus by the prominently white forewing costa. In other respects, it is similar to other members of the section.

Only a single pair is known, hence genitalia were not examined. It is rare in the type locality, where it has a single annual generation during the second half of the southwest monsoon.

With reference to the antennae and palpi, the difference between the sexes is similar to that found in *Comostola*

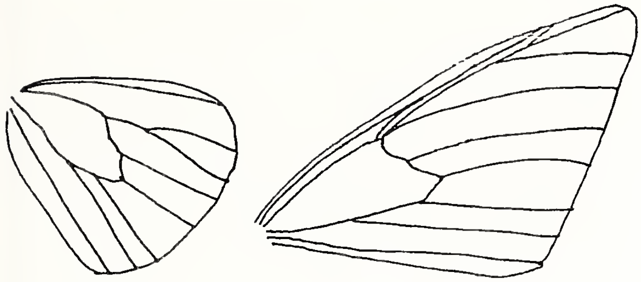


Fig. 2: Forewing and hindwing venation of holotype of *Comostola hauensteini* sp. nov. (not to scale)

subtiliaria nympha Butler, where the female has simple antennae and longer palps than the male.

In Fig. 2, the characteristic venation of the cells of both wings of *C. hauensteini* is illustrated. The subcostal venation of the forewing is not depicted, since it is not diagnostic.

The species is dedicated to Armin Hauenstein of Untermünkheim-Schönenberg, Germany.

3. *Garaeus parva* von Hedeman (Geometridae: Ennominae)

Garaeus parva is a polytypic Asian moth, with a recorded distribution from Siberia and Japan southward through China to the hills of northeast India. Recently, it has been recorded from Jones Estate. These records extend the known distribution of the species considerably westward along the Himalaya.

Wehrli (1940) recognized six subspecies of this moth, four from the Asian mainland and two from Japan: the nominotypical race from Manchuria and Siberia; *distans* Warren and *kiushiuana* Hori from Japan; *notia* Wehrli from Central and Southern China; *sutschana* Wehrli from the Sutschan (=Sushan) area in Ussuri, Russia and *discolor* Warren from West China and northeast India. Hampson (1895) gave the Khasi and Naga Hills as localities for *discolor*. The original and subsequent descriptions of *discolor* (Hampson 1895; Prout 1915; Wehrli 1940) are of what appear to be Dry Season Form males. Although both sexes of the remaining subspecies appear to be known, the female of *discolor* was unknown. The following is a description of Wet Season Form (WSF) males and both the WSF and Dry Season Form (DSF) of the female.

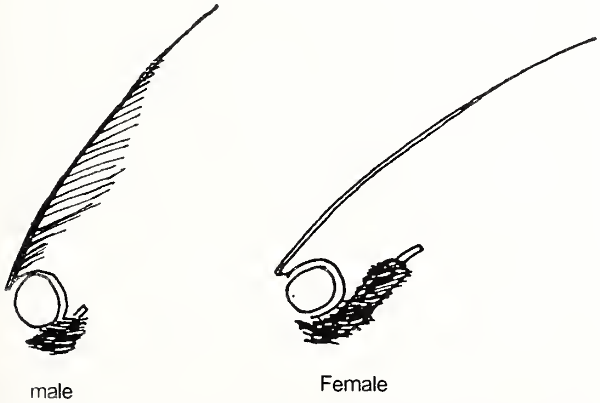


Fig. 3: Head of male and female of *Comostola hauensteini* sp. nov. (not showing sections of labial palpi)

Garaeus parva discolor Warren

1893. *Proc. zool. Soc. Lond.*: 400, pl. 32, fig. 19.

Wet Season Form Male

Material Examined: Holotype: 7.viii.1997.

Forewing Length: 17 mm; expanse: 38 mm.

Paratype: 5 exs.: 23.vii.2000; 3.vii.2002; 14.viii.2001; 24.viii.1997; 19.ix.2000.

Forewing Length: 15-17 mm; expanse: 32-38 mm.

Diagnosis: Head grey, collar brownish grey, thorax and abdomen grey and coppery. Antennae grey. Forewing *recto* ground colour bright coppery to reddish-brown with some dark irroration. Costa greyish white as far as postmedial white mark. Base suffused with grey, especially on costa. Prominent grey antemedial band angled below costa. A dark medial line, which is not prominent in some specimens, arising from costa, angled at discocellular spot, whence it runs obliquely to inner margin. Diffused grey postmedial band arising from a white spot on costa and bordering dark medial line from discocellular spot to inner margin. A white stigma before apex. Some greyish submarginal suffusion above tornus. Cilia of both wings dark brown.

Hindwing *recto* coppery brown suffused with pale grey, particularly near the dark antemedial line. A series of dark medial spots terminating in a black and white mark on inner margin. Postmedial series of large, irregular, white-ringed coppery spots not reaching costa, coppery colour replaced by brown in some individuals.

Forewing *verso* brown suffused with pale grey. Subbasal area with some chocolate brown suffusion on costa and below cell. Sinuous, diffused but prominent chocolate brown medial band. Triangular chocolate brown subapical costal patch bordered with white. Indistinct pale postmedial and crenulate submarginal bands.

Hindwing *verso* brown irrorated with grey. Prominent chocolate brown antemedial band. Medial spots and postmedial rings of *recto* surface present, though not as prominent.

Comparison with dry season form males: The most striking difference is in the coppery suffusion on the *recto* surface and the prominent markings on both surfaces of the WSF. The markings are greatly reduced or obscured in the DSF. While the antemedial and medial bands on the forewing *recto* are almost obsolete in the DSF, they are well developed in the WSF. The grey postmedial band, which is indistinguishable in the DSF, is prominent though with diffused edges in the WSF.

On the hindwing *recto*, the most prominent difference between the seasonal forms is in the postmedial series of white-ringed coppery spots, which are prominent in the WSF and almost obsolete in the DSF. On the *verso* surface, these spots are vaguely distinguishable and were referred to by Hampson (1895) as an "indistinct waved submarginal white line".

Comparison with other subspecies: The WSF of *discolor* is very similar to the race *sutschana* Wehrli described from material from Sutschan (=Sushan), Ussuri (east of Vladivostok, Russia) which, incidentally, is at the opposite extreme of this insect's range. The similarity lies chiefly in the ground colour of the *recto* surface, which according to Wehrli (1940) is olive-grey red-brown dull-coppery, faintly suffused with whitish in *sutschana*. Besides this, the prominent dark red brown medial line on the forewing, lightly suffused with dark grey, agrees well with that of the WSF of *discolor*, as does the dark band on the *verso*, which is chocolate brown in *sutschana* as well as in the WSF of *discolor*.

In the Himalaya, *G. parva* is on the wing throughout the year, while in Siberia, Manchuria and Japan, it has been recorded in late June and July. Presumably it is on the wing only during the summer months in the northern part of its range. Therefore, it is unlikely that distinct seasonal forms occur there, as they do in the Himalaya.

However, taking into consideration that the "subspecies" *sutschana* is known from an area well within the range of *G. parva parva*, the similarity between *sutschana* and the WSF of *discolor*, and that *sutschana* differs from *parva* more or less in the same manner that WSF *discolor* differs from DSF *discolor*, it appears possible that *sutschana* is a form of the subspecies *parva* rather than a good subspecies.

Female

Material Examined: Holotype: 30.xi.1998.

Paratypes: 5 exs.: 23.i.1999; 5.v.1999; 18.xi.1996; 1 ex. no date; 16.x.2003.

Forewing Length: 17-19.5 mm, expanse: 38-44 mm.

Diagnosis: Antennae ochreous, bipectinate to apex, rami dark brown, shorter than those of males. Head, thorax and abdomen ochreous. Collar darker.

Basal half of forewing costa arched. Apex acute, outer margin excised below apex. Hindwing with outer margin crenulate and tornus lobed.

Forewing *recto* with ground colour ochreous. Traces of pale antemedial band angled below costa. Medial dark streak on costa. Black speck at end of cell. Triangular white postmedial costal mark, defined by dark brown, from which a prominent, oblique dark line arises and terminates at middle of termen. Black speck on M_1 (vein 6) beyond postmedial line. A white striga from apex. Some individuals with diffuse dark submarginal spot below M_3 (vein 4), below which submarginal area is suffused with greyish brown.

Hindwing *recto* ochreous, costal area pale. Antemedial straight dark line in continuation of forewing's oblique dark line. Barely discernable incomplete medial series of dark specks terminating in a V-shaped dark mark on inner margin or termen. Distal half of wing evenly suffused with greyish-brown, crossed by irregular ochreous postmedial band from apex to tornus. Cilia of both wings dark brown.

Forewing *verso* light brown, suffused with dark brown scales. Sub-basal darker brown area distally defined by antemedial line. Sinuous, excurved brown medial band, dark speck at end of cell. Prominent dark sub-apical triangular patch on costa. Dark spot below triangular mark on M_1 (vein 6). Submarginal area suffused with dark brown with ill-defined, crenulate submarginal line and diffuse, dark submarginal spot below M_3 (vein 4), extending to margin in some individuals.

Hindwing *verso* with proximal half ochreous, with some dark brown suffusion along costa. Straight, dark antemedial line and dark speck at end of cell. Distal half of wing suffused with darker brown beyond medial series of dark specks. Crenulate, ochreous postmedial line and some ochreous suffusion at and below apex.

Individual and seasonal variation

Recto: The specimen from January is the darkest, with the postmedial dark suffusion on both wings prominent. The specimen from May has the least dark suffusion and lacks postmedial markings on the forewing. On the hindwing, these markings are faint. The November specimens, including the type, have hardly any dark suffusion on both wings and have a rufous tinge. The Wet Season Form females (16.x.2003 and the undated specimen) are suffused with rufous instead of dark brown, and are the largest of the six specimens. The white subapical mark on the costa of the undated specimen is almost wholly suffused with dark brown. I have an identical specimen, unfortunately in pieces with the abdomen and one hindwing missing, these having been devoured by a Tit, which was taken on 28.ix.2003.

Verso: On the *verso* surface, too, the specimen from January is the darkest, with well-defined markings. Next in order is the May individual, while the two November specimens are paler with some obsolete postmedial markings on both wings. The Wet Season Form females are suffused with rufous instead of dark brown, and the subapical triangular patch on the forewing is rufous in one case. On the forewing, a postmedial series of specks on the veins is discernable.

Remarks: The females described above differ superficially from males, especially in the ochreous ground colour, the uniform colouration and the prominent dark medial line on the forewing *recto*. They closely resemble the form *nigrilineata* Prout, an unusual form described from Lienping, northeast of Canton in China. The ground colour of females of *discolor* is a little more irrorated with grey or rufous, depending upon the season, than in the *nigrilineata* illustrated on Plate 25 f of the Palaearctic Geometridae (Supplement) in Seitz (1954), the oblique postmedial band on the forewing *recto* is a little further away from the discocellular spot in females of *discolor* than in the illustrated *nigrilineata* and the latter lacks the dark.postmedial speck on M_1 (vein 6).

From a comparison of the sexes of *discolor*, it is quite evident that, besides being sexually dimorphic, it is also seasonally variable. Prout (1915) and Wehrli (1940) do not note this. Although the sex and date of collection of *nigrilineata* is not noted, the illustration is that of a female, judging by the antennal characters. It seems possible that it is a Wet Season Form female of subspecies *notia* Wehrli, which is found in the area.

According to Prout (1915), *parva* emerges in July in Manchuria, Vladivostok and Japan. From this, it appears that the moth is univoltine in the northern part of its range. It is, therefore, obvious that there will be no seasonal variation, although there may be some individual variation. The present records are from an area with sharply defined dry and wet seasons, the latter being the period when the southwest monsoon is in progress from June to late September. The species has been recorded in January, May, August, September, October and November in Bhimtal, indicating that there are at least three annual generations. It seems likely that there is a fourth or even fifth generation between August and November.

The series of five females from different months show a range of variation encompassing the form *nigrilineata* from the Omei-Shan (Lienping) and the Japanese *distans* Warren depicted in Seitz (1954), especially in the forewing markings.

Both Prout (1915) and Wehrli (1940) did not mention sexual dimorphism in this species, but noted that very little material had been examined as specimens were scarce, from which one may assume that, unlike the case in the Himalaya, the sexes are superficially similar in eastern China, eastern Russia and Japan.

This assumption is strengthened by the illustrations of this species in Seitz (1954) where, on the basis of the antennae and size, it can be suggested that females of *parva*, *nigrilineata*, *notia* and *distans* have been depicted, while *discolor* and *sutschana* Wehrli are represented by males. From these, it seems likely that sexual dimorphism is not present in *parva*, but might be so in *distans*, and by the form *nigrilineata* in subspecies *notia*.

Ecology: This moth is rather rare in collections. Wehrli (1940) noted that it is not common in Manchuria and Vladivostok, while only a few had been collected in Japan, on which the subspecies *distans* and *kiushiuana* Hori were based.

In the Bhimtal valley, it is rare at mercury vapour light, where males are attracted. Females are not attracted to artificial light and it is likely that males, too, are not often attracted. If the latter proves to be the case, the moth might be commoner than has been assumed over most of its range. This is borne out by the observation that males, even when attracted to artificial light (from mercury vapour lamps), generally settle in light shadow some distance (up to 5 m) from the light source. The females recorded were found within rooms (specimen dated 18.xi.1996 and the undated Wet Season Form) or in the open during the daytime. The undated female was found on a windowsill of a disused room during the late 1970s, lacking its head and antennae. Male specimens collected during the 1970s have been identified from photographs, so the moth has probably been present in the Kumaon Himalaya for at least 30 or 40 years, probably longer.

Prout (1915) noted that the larval host plant of ssp. *parva* is *Ligustrum ibota*. Three species of *Ligustrum* L. have been recorded from Kumaon between 5,000 ft (1,524 m) and 9,000 ft (2,743 m), with one species, *L. nepalense* Wall. descending to 3,000 ft (914 m) in the central and inner ranges (Osmaston 1927). However, it is equally likely that the species feeds on some other plant, perhaps belonging to Oleaceae, in the Himalaya.

That it is a species capable of great adaptation is evident not only from its distribution, but also from its flying period, from January (the day when the specimens were recorded the minimum and maximum temperatures were 11 °C and 14 °C respectively), to May (the day when the specimen was recorded the minimum and maximum temperatures were 25 °C and 36 °C respectively). Relative humidity varies from 6% to 1% (reaching 1% when warm summer breezes blow) during April and May, to 100% on foggy days during the southwest monsoon. Given its Palaearctic distribution, this moth will almost certainly also be found at higher elevation in this area, i.e. up to 2,500 m, if not higher. However, this moth has been recorded so far only from Jones Estate.

The present specimens, along with a series of DSF males in my collection, constitute the first Himalayan records for this moth, and it will almost certainly be found all along the range eastward, i.e. in Nepal, Sikkim, the hill districts of

West Bengal, Bhutan and Arunachal Pradesh. It is not known whether it occurs west of Jones Estate, but given its rather stable population here, it is likely to be found in some neighbouring valleys to the west also.

The moth has a weak, fluttering flight, and settles in shady places with wings outspread, in the manner typical of most Geometrids. It is eaten by birds, and I have found bitten-off wings after Tits (*Parus major* L. and *Parus xanthogenys* Vigors) fed on moths attracted overnight to the verandah light. All the specimens discovered outdoors were settled among low scrub and bushes, where they look remarkably like dry leaves. This is not to say that they do not fly at higher levels, for example among the canopies of trees, since these have not been examined.

4. ***Hypochrosis hyadaria*** **Guenée (Geometridae: Ennominae)**

1857. *Hist. Nat. Ins. Lep.: Uran. Et Phal.* 2: 537.

The Geometrid moth *Hypochrosis hyadaria* Guenée was recorded by Hampson (1895) from Sikkim, Khasi Hills, Nilgiris and Sri Lanka. It is also well established in the Kumaon Himalaya west of Nepal, where it has been recorded at Jones Estate at 1,500 m above msl.

The moth is quite variable, and Hampson (1895) while synonymising nine names under *hyadaria*, retained four names for different forms in addition to the typical form, and an unnamed variety. These are *tinctaria* Walker from Shillong (Meghalaya), which is dark greyish-purple, with the costal area of the hindwing *recto* reddish-orange and the underside redder than the typical form. This form has also been recorded at Jones Estate. The Nilgiri and Sri Lankan forms *sulphurescens* Moore and *galbulata* C. & R. Felder are greenish, especially between the ante- and postmedial lines of the forewing, which in *galbulata* approach each other towards the inner margin. The form *flavifusata* Moore has the medial and outer areas of the forewing yellow except at the outer angle. The latter two forms have not been recorded from Kumaon in the present study.

Hampson's unnamed variety, which he recorded from the Khasi Hills, has the lines of the forewing dark at the costa and a large submarginal black blotch on the inner area. This form, which has been recorded in the present study, is referred to as ***stigmata*** forma nov.

Material examined: This species was collected at a single location in Jones Estate, Bhimtal, over a period of thirty years. All specimens were attracted to mercury vapour lamps. Sixty-three specimens were examined, as well as photographs of twenty specimens collected at the same location.

The species has been recorded in every month from February through October. It is relatively common and well established, most abundant in March and April and seen in smaller numbers during the remaining period.

Remarks: The moth is seasonally variable. The typical form has only been recorded during the dry season before and after the southwest monsoon, and is therefore the Dry Season Form. The form *tinctaria* has only been recorded during the southwest monsoon months from July to September and is therefore the Wet Season Form. In the material examined, there are very few females of the typical form, i.e. two recorded in February. The normal female form in this area may be referred to the form *sulphurescens* as it has the basal and distal (outer) area of the forewing brown and the area between the ante- and postmedial lines greenish-yellow. No males of this form have been recorded in the present study. In just a few individuals, there is an obscure dark mark at the forewing tornus in the same place as in form *stigmata*. In only one female specimen of *sulphurescens*, recorded on 25.iii.2001, is the tornal mark prominent. This individual is included in the type series of *stigmata* further on.

This form is paler during the dry season and darker during the wet season, and the two seasonal forms have numerous intergrades, so that it is not possible to say with certainty where the WSF begins and the DSF ends.

The form *stigmata* has been recorded in every month except February, September and October. During the dry season the ground colour is that of the typical form, but during the wet season, what may be described as *stigmata* x *tinctaria* are on the wing alongside normal *tinctaria*.

The holotype of *stigmata* is a Dry Season Form individual taken on 26.v.1998 with a forewing length of 18 mm and an expanse of 38 mm.

Paratypes: 11 exs.: 4.iii.1999; 14.iii.2001; 25.iii.2001 (♀ *sulphurescens* x *stigmata*); 29.iii.2001; 22.iv.2001; 1.vi.2000; 8.vi.2000; 17.vii.1990; 26.vii.2000; 29.vii.2000; 9.viii.2000.

Forewing length 17-21 mm; expanse 36-44 mm.

On the whole, the specimens examined in the present study are larger than those examined by Hampson (1895), who gave an expanse of 34 to 40 mm for the species. The present material measures 36 to 46 mm, with the length of the forewing varying from 17 to 21 mm.

Males have a 5 mm long, hairy, white pair of coreomata that can be extruded from near the ventral tip of the abdomen.

5. ***Anambulyx elwesi*** **Druce (Sphingidae: Sphinginae)**

1882. *Entomol. Mon. Mag.* 19: 17.

The monobasic genus *Anambulyx* Rothschild & Jordan is known from Thailand (Cadiou and Kitching 1990), the Khasi Hills (Bell and Scott 1937), Darjeeling (type locality), and Kumaon (Smetacek 1994). The species occurs roughly between 1,500 m and 2,300 m above msl. The Kumaon population belongs to the western extreme of the insect's known range. Due to some consistent differences between the fascies of the Bhimtal population and the populations from the east, it is desirable to treat the Bhimtal population as a subspecies of *elwesi*. The following is a description of material from the Bhimtal valley.

Anambulyx elwesi kitchingi ssp. nov.

Material Examined: Holotype: male 30.vi.1990. Kumaon Himalaya (Wet Season Form).

Forewing Length: 40 mm. Expanse: 90 mm.

Paratypes: Female 16.iii.1999 (Dry Season Form); 4 males 11.vi.1996; 25.vi.1992; 10.vii.1989; 17.viii.1995.

Forewing Length: Female: 52 mm (apex of both forewings missing); males: 40-45 mm.

Expanse: Female: 116 mm; males 90-100 mm.

Diagnosis: Antennae light brown. Head, thorax and abdomen grey, lightly tinged with brown. Broad, triangular, dorsal, dark brown patch on thorax, broadest towards abdomen. Abdomen with narrow dorsal dark line. Legs brown, upper edges of femur flushed with pink.

Forewing *recto* with apex produced. Irregular dark brown basal patch. Lime green patch extending from basal patch, into which it sends two dentitions, to nearly halfway along costa, lower edge of green patch extending along a narrowing spur to tornus. An obscure, sinuous antemedial line, broadening into prominent green patch on inner margin. Green stigma at end of cell. Sinuous postmedial and double submarginal lines, the former faintly marked. All three lines distally edged with grey powdering.

Hindwing *recto* with proximal half rosy pink, distal half brown with grey stigma near tornus. Inner margin paler.

Forewing *verso* brown, with rose pink flush on basal half. Subapical grey patch from which an almost straight postmedial line arises.

Hindwing *verso* brown suffused with grey, suffusion lacking between antemedial and medial lines. Slight basal pink suffusion in interno-medial interspace. Evenly curved, brown postmedial line arising from just before apex, terminating above tornus. Area around tornus darker than rest of wing.

Dry Season Form: (female): Differs from WSF described above in the grey and brown areas being generally paler, except dorsal thoracic brown patch. On forewing *recto*, oblique green patch extends distad in cell causing irregularity in border of patch.

Forewing *verso* with costa flushed with green, postmedial line on both wings distally bordered with green. Hindwing *verso* faintly flushed with pink.

A female of the Wet Season Form measured in an earlier paper (Smetacek 1994) is smaller, with a forewing length of 49 mm compared with 52 mm despite the missing apex of the present specimen.

Comparison with the nominate subspecies: It is well known that in many Lepidoptera there exists a cline along the southern face of the Himalaya, with darker races in the humid eastern Himalaya and pale forms in the drier western Himalaya. The present case seems to be another example of this, for ssp. *kitchingi* differs from the nominate subspecies primarily in being paler, so that the markings on the forewing are easily discernable, especially the postmedial and submarginal lines. In addition, the dark dorsal triangular mark on the thorax contrasting with the paler greyish-brown of the sides and the paler abdomen easily distinguish ssp. *kitchingi* from ssp. *elwesi*, which has a uniform dark thorax and a similar dark abdomen.

The green markings on both surfaces of the forewing fade to ochreous in a few years in stored specimens, hence earlier descriptions (including the original description) of *elwesi* refer to the lime green areas as ochreous.

The subspecies appears to be restricted to the Himalaya west of Nepal, where it has only been recorded from Bhimtal so far.

The subspecies is dedicated to Ian J. Kitching of the Natural History Museum, London.

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NEW DESCRIPTIONS

EXISTENCE OF THE ORDER BATHYNELLACEA (CRUSTACEA, SYNCARIDA) IN SOUTH ASIA: A NEW SPECIES OF GENUS *HABROBATHYNELLA* SCHMINKE 1973, FROM RIVER PENNAR, SOUTH INDIA[1]

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A new species of the genus *Habrobathynella* Schminke 1973, is described from River Pennar near Cuddapah, South India. Named *Habrobathynella schminkei*, the new species belongs to Family Parabathynellidae. It differs from its two known Madascan congeners, *H. milloti* and *H. jeanneli* (Delamare and Paulian 1954) in several morphological details, namely the presence of one ventral plumose seta at distal inner angle of sympodite of uropod; two strongly unequal setae on the basal segment of maxilla; much elongated endopodite on uropod; absence of seta on third endopodite segment of thoracopods I-VII. A key to the identification of the three species of *Habrobathynella* is also given.
This is the first report of the Order Bathynellacea in South Asia, while the record of *Habrobathynella* in South India fills the vast gap in the distribution range of the Family Parabathynellidae, and lends support to the East Asian origin of this family.

Key words: *Habrobathynella schminkei* sp. nov., Bathynellacea, Parabathynellidae, taxonomy, India

INTRODUCTION

Bathynellacea are minute, eumalacostracan crustaceans, usually inhabiting the mesopsammon, i.e. the interstitial water in the spaces between sand grains of lakes, rivers, streams and wells. The only exceptions are two species living as relicts in Lake Baikal at a depth of 100-1440 m (Bazikalova 1954) and one species in an Australian marine beach (Schminke 1972). The living Bathynellacea represent one of the oldest groups of freshwater carcinofauna, whose ancestors inhabited the sea during the Carboniferous period, or even earlier (Schminke 1974). Today bathynellaceans are known from all over the world, except Antarctica. It is paradoxical that despite the fact that the first Asian species was recorded from a cave in Malaysia as far back as 1929 (Sars 1929), and that the centre of evolution of Bathynellacea is East Asia, practically nothing is known of this group from the whole of the South Asian region. There are, however, several published reports from other parts of Asia (see Lopretto and Morrone 1998).

The Order Bathynellacea is comprised of two families: Bathynellidae and Parabathynellidae. Schminke's (1986) survey has revealed more than 150 known species belonging to 42 genera in these two families.

This paper gives the description of a new species of the genus *Habrobathynella* Schminke 1973, belonging to the Family Parabathynellidae. While revising this family, Schminke (1973) established the above genus for two species, both from Madagascar: *Habrobathynella milloti* (Delamare and Paulian 1954), the type species, and *Habrobathynella jeanneli* (Delamare and Paulian 1954). *Habrobathynella schminkei* sp. nov. is the first representative of the Order Bathynellacea from South Asia, as well as of the genus *Habrobathynella* from Asia.

It is hoped that this fortuitous discovery of *H. schminkei* sp. nov. will be a precursor to studies on the possibly rich biodiversity of the neglected hyporheic and phreatic environment of South Asia. This hypogean habitat is a promising place not only for biologists to look for new insights into adaptation and speciation (Barr 1968, Rouch 1986), but for geologists as well to delve into the evolutionary history of the earth.

METHODS

The sampling site was River Pennar at Chennur, *c.* 15 km from Cuddapah town, South India. About ten core samples were collected at various points of the submerged riverbank, overlaid with a loose deposit of fine sand. A rigid PVC tube (length 70 cm, diameter 4 cm) was used for coring. The cores taken from the sediment surface to a depth of 20-30 cm were pooled into a bucket and vigorously stirred with the habitat water. The supernatant was filtered through bolting silk plankton nets (mesh size 70 μm). The filtrate was fixed in 20% alcohol and then preserved in 70% alcohol. Specimens were dissected in glycerol, using a stereoscopic binocular microscope at 90x; body parts were mounted under cover slips and sealed with Araldite. Measurements were made with an eyepiece micrometer, and drawings made with Camera Lucida on a compound microscope at magnifications of 150x, 270x, 450x 675x or 1000x. Appendages were largely dissected before drawing, while lateral views were drawn *in situ*. Body length was measured from the anterior margin of the head to the end of the caudal furca.

KEY TO THE SPECIES OF THE GENUS *Habrobathynella*

1 Sympodite of uropod with a seta at distal inner corner; pleotelson setae shorter than caudal furca .... *H. schminkei* sp. nov.

— Sympodite of uropod without seta at distal inner corner; pleotelson setae as long as caudal furca 2

2. Antennule elongate, apophysis on segment 4 shorter than segment 5; exopodite of uropod with spinous projection at inner terminal corner .... *H. milloti*

— Antennule short, apophysis on segment 4 reaching end of segment 5; exopodite of uropod without spinous projection .... *H. jeanneli*

Systematic position

Subclass Eumalacostraca Packard 1892
Superorder Syncarida Packard 1885
Order Bathynellacea Chappuis 1915
Family Parabathynellidae Noodt 1965

Habrobathynella schminkei sp. nov. (Figs 1-4)

Type locality and material examined: River Pennar at Chennur, *c.* 15 km from Cuddapah town (14° 28' N, 78° 49' E), South India, 45 males, 60 females, 15 juveniles. 18.i.2000. Coll. M.V.S. Kishore Kumar.

Holotype (female), allotype (male), paratypes (10 males, 10 females), all undissected, were deposited in the Natural History Museum, London. Regn. nos.: Holotype: 2002.5, allotype 2002.6, paratypes 2002.7-26. Dissected and some undissected paratypes (25 males, 40 females) are in the author's collection.

Other locality: River Godavari at Rajahmundry town (16° 9' N, 81° 47' E), South India. Only 2 females from fine sand at the middle of the river basin, water depth *c.* 1.25 m, 29.i.1999. Coll. Y. Ranga Reddy.

Description of adults

Adult female: Total length: Holotype 1.04 mm; paratypes 0.80-1.04 mm, mean 0.90 ±0.06 mm (n = 55). Body elongate, 13 times longer than maximum width. In lateral view, abdominal segments wider than thoracic segments (Fig. 1). In dorsal view, body vermiform uniformly narrow. Head 27.7% longer than wide, and about as long as first 2 thoracic segments combined. Anal operculum protruding, concave medially, sometimes extending to end of caudal furca (Fig. 2d), in lateral view, posterodorsal end variable in shape (Figs 2e-j). Pleotelson with 1 seta on either side at base of caudal furca; seta bare, shorter than caudal furca.

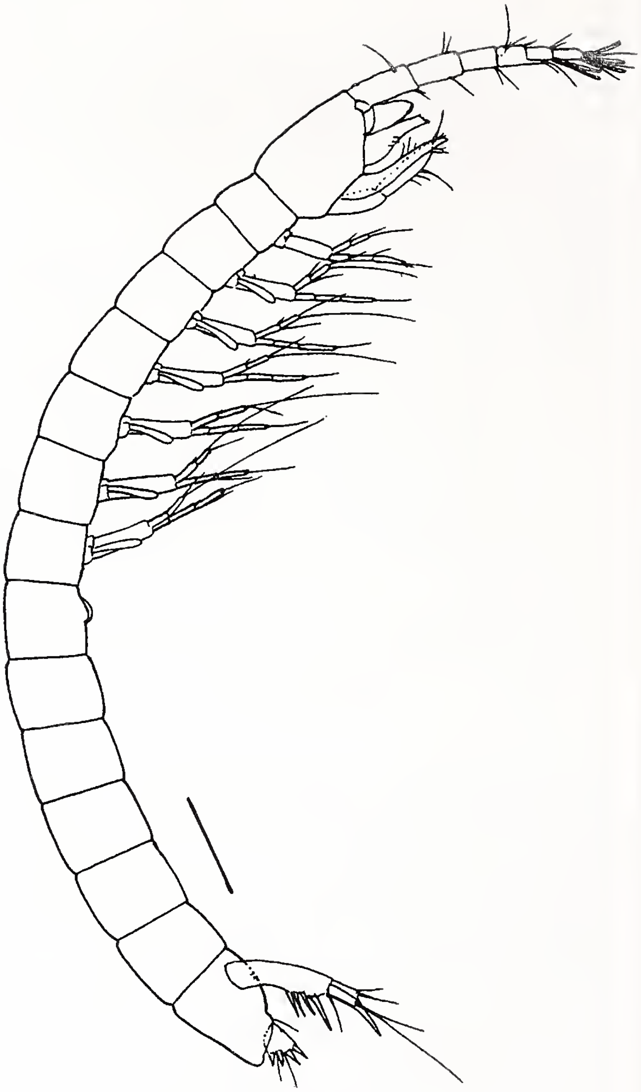


Fig. 1: *Habrobathynella schminkei* sp. nov., adult female, holotype, lateral view. Scale = 100 µm

Caudal furca only slightly longer than maximum width, distal part expanded and rounded, with 2 terminal and 2 inner, pointed, serrulate spines, and 2 dorsal setae; terminal spines longer than inner ones. Furcal organ small, ventral.

Antennule (Fig. 2k) 6-segmented, 34.5% longer than head; first segment thickest, the remainder becoming progressively thinner. Length of first 3 segments distinctly greater than that of last 3; apophysis of segment 4 slender, overreaching only mid-length of next segment. No sexual dimorphism. Segments 5 and 6 with 2 and 3 aesthetascs, the former somewhat longer. Setation, as observed under optical microscope, illustrated in Fig. 2k.

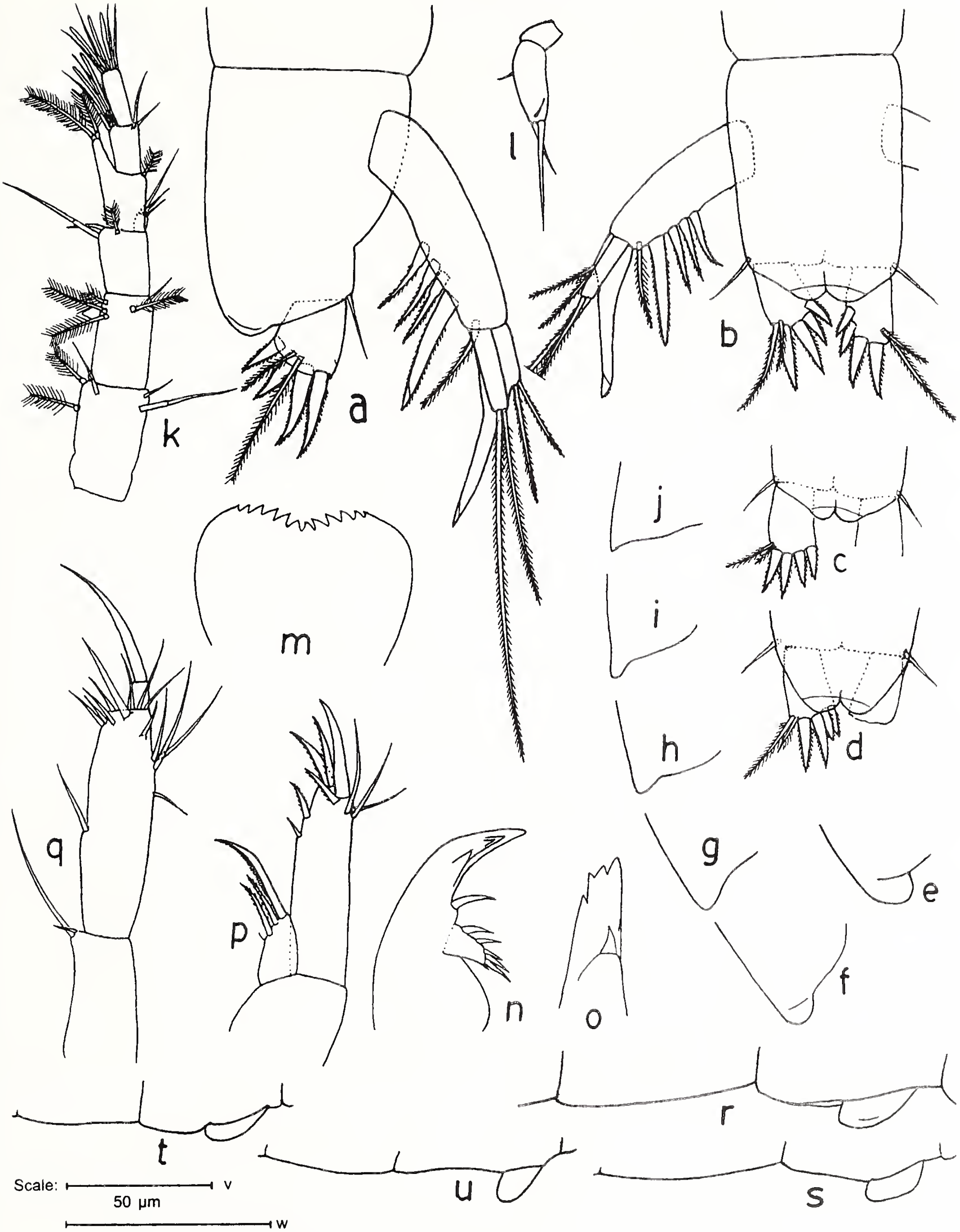


Fig. 2: *Habrobathynella schminkei* sp. nov., adult female. a. pleotelson, lateral; b. pleotelson, dorsal (right uropod omitted); c. posterior part of pleotelson, dorsal (right caudal furca omitted); d-j. posterior end of pleotelson, lateral view; k. antennule dorsal view; l. antenna; m. labrum, ventral view; n. mandible, lateral view; o. mandible, *pars incisiva* (with proximal tooth), frontal view; p. maxillule; q. maxilla; r-u. thoracic segment 8 and abdominal segment 1, lateral view. Scale: v (for figures a-k, r-u) = 50 μm; w (for figures l, m-q) = 50 μm.

Antenna (Fig. 2l) small, 2-segmented; proximal segment much smaller than distal one and unarmed; distal segment 2.5 times as long as wide, with 2 unequal terminal setae, 1 small subterminal seta on dorsal surface and 1 similar seta on outer proximal margin.

Labrum (Fig. 2m) dentate margin somewhat vaulted on either side, bearing 10 main, nearly uniform, pointed teeth and 1 smaller tooth on each side.

Mandible (Figs 2n, o) distal part of *pars incisiva* with 4 unequal teeth, distal tooth relatively large; proximal tooth large, curved and pointed. *Pars molaris* developed into somewhat pyriform outgrowth, carrying 2 isolated, curved teeth on inner margin and 3 straight pointed, unequal teeth in a group at proximal end; also, 1 denticle occurring at outer proximal corner, all teeth smooth, articulate and apparently without setules. Palps completely absent.

Maxillule (Fig. 2p) consisting of 2 endites; proximal endite small, elongately oval, carrying 1 long, thick, falcate, terminal spine with finely serrulate inner margin, 2 small, equal setae, and 1 setule on subterminal inner margin. Distal endite cylindrical, 2.5 times as long as proximal endite and with 4 terminal claws, distal one large and smooth, others with serrulate margins; also, 2 unequal spines occurring on subterminal inner margin and 3 setae on subterminal outer margin.

Maxilla (Fig. 2q) 3-segmented; basal segment 1.7 times as long as wide, with 2 strongly unequal setae on small protuberance at distal inner corner. Second segment nearly twice as long as basal segment and armed with 13 setae, and 1 straight spine at distal inner corner. Third segment small, oval, carrying 1 stout claw and no setae.

Thoracopods I-VII (Figs 3a-g) 7 pairs of well-developed thoracopods, gradually increasing in size from pairs I to III, last 5 pairs of nearly similar size; well-developed, biarticulate, club-shaped epipodite on pairs II-VII, at least 0.7 times as long as basis. On all thoracopods, coxa with distinct conical projection at distal inner border, and basis with 1 weak seta at similar position.

Thoracopod I (Fig. 3a) short, exopodite 2-segmented, 0.7 times as long as endopodite; segment 1 only slightly longer than segment 2 and with 2 short, almost equal, plumose setae, 1 dorsal, 1 ventral; segment 2 with 2 terminal setae, outer one plumose and slightly shorter than spiculated inner one; ctenidia lying at base of inner seta. Endopodite 4-segmented, segment 1 about half of segment 2 and with 1 weak seta at distal inner corner; segment 2 longest with 1 plumose seta at distal outer corner; third segment unarmed; segment 4 shortest, rectangular, with 2 unequal, smooth, terminal claws.

Thoracopods II-VII (Figs 3b-g): Exopodite 2-segmented, about 0.8 times as long as endopodite; segment 1 1.3-1.5 times longer than segment 2, with 2 unequal plumose setae, ventral one as long as segment 2 on Thoracopod II, but distinctly shorter on Thoracopods III-VII; segment 2 with 2 terminal, unequal setae, outer one plumose, inner one spiculated; ctenidia at base of inner seta. Endopodite 4-segmented, segment 1 short, unarmed; segment 2 longest and with 1 outer plumose seta, extending beyond segment 4 and also with ctenidia at distal inner corner and spinules on inner margin, except for a short distance proximally; segment 3 without seta, but with ctenidia as on segment 2; segment 4 smallest, rounded, with 1 terminal claw.

Thoracopod VIII (Fig. 2r-u) relatively large, undifferentiated, plate-like or somewhat crescentic.

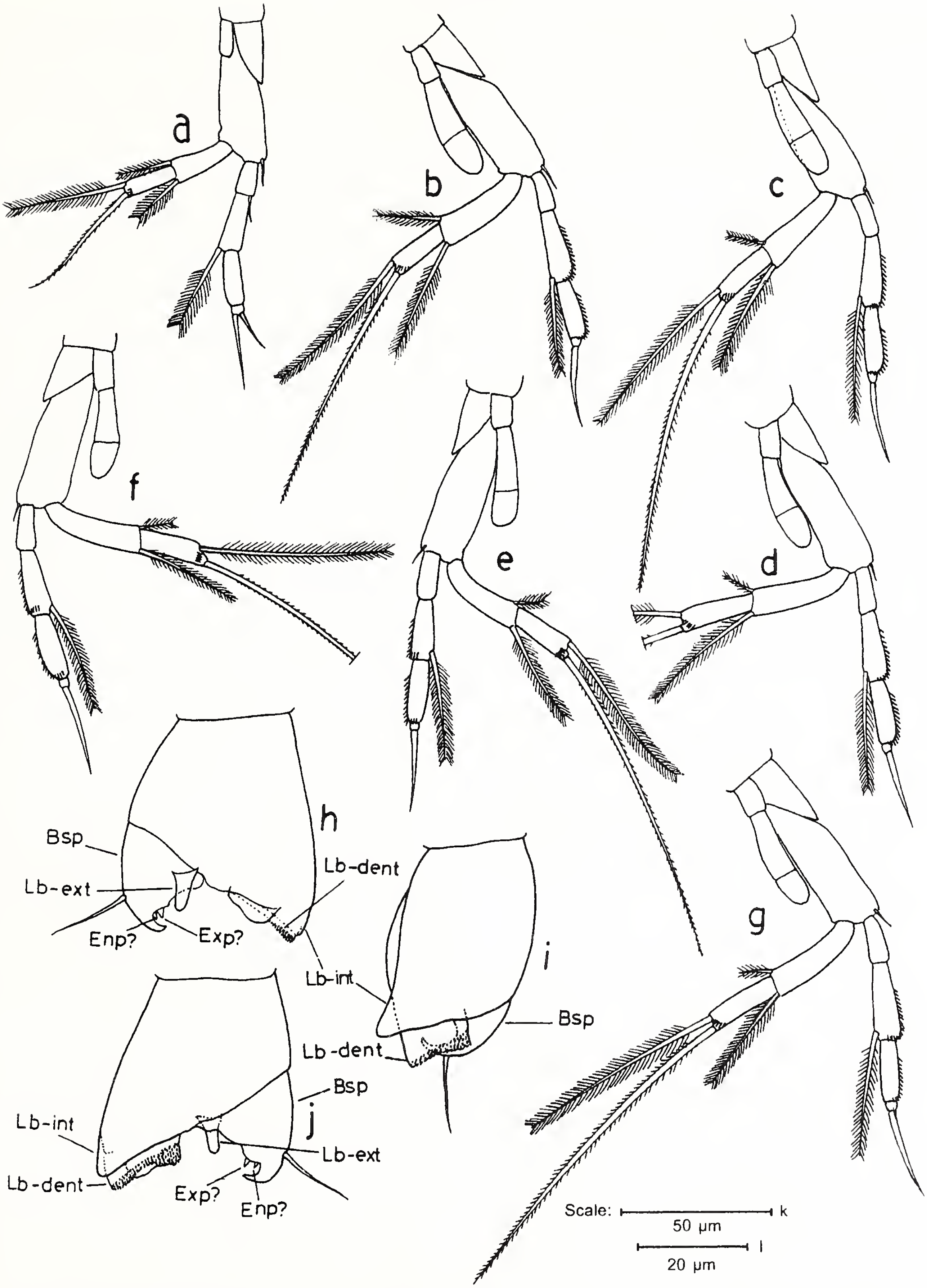
Uropod (Figs 2a, b): Sympodite nearly 4 times as long as wide, bearing 4 spines, and 1 seta on inner distal margin; distal spine almost straight, serrulate, distinctly stouter and 29% longer than others; other spines equal in size, setiform, with proximal fourth slightly dilated, beyond which lateral margins serrulate; proximal spine generally curved anteriorly. Exopodite cylindrical, 4 times longer than wide, measuring 34% of sympodite length and carrying 2 terminal, unequal, plumose setae. Endopodite falcate, reaching 86% of sympodite length; distal inner margin serrulate; 2 unequal, relatively short, plumose setae at proximal fourth of outer margin.

Adult male: Total length: allotype 0.96 mm, paratypes 0.72-0.96 mm, mean 0.83 ±0.07 mm (n = 40). Body and all appendages except Thoracopod VIII as in female.

Thoracopod VIII (Figs 3h-j) large, subglobular and longer than wide. Outer lobe conical, apparently smooth, defined at base and blunt apically. Dentate lobe large, concave at mid-length, longer than inner lobe, with 2-3 rows of fine denticles along free margin and also a group of additional denticles at anterior corner (Fig. 3j); a large, somewhat crescentic lobe adnate to anterior half of dentate lobe, seen clearly in latero-external view. Inner lobe linguiform in rostral view. Basipodite triangular, ending in pointed hook and carrying 1 lateral seta. Two tiny triangular lobes of slightly unequal size, probably representing exo- and endopodites, lying close to each other at distal angle of basipodite below the terminal hook.

Description of juveniles: In all, 14 juveniles, representing only two distinct instars, were recorded.

Instar I: Sexually undifferentiated. Total length 0.58-0.65 mm, mean 0.61 ±0.02 mm (n = 6). Body form as in adult, 12 times longer than maximum width. Abdominal segments wider than thoracic segments. Head 26.5% longer than wide. Antennule 32.5% longer than head. Body segmentation and various details of cephalic appendages and caudal furca as in adult, but differing in the following respects:


a
b
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g
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j
Lb-ext
Lb-dent
Exp?
Enp?
Scale:
k
50 µm
l
20 µm

Fig. 3: *Habrobathynella schminkei* sp. nov., adult female, a-g. thoracopods I-VII, respectively. Adult male, h-j. Thoracopod VIII (Bsp = basipodite or basis; Lb-ext = external lobe; Lb-int = internal lobe; Lb-dent = dentate lobe; Exp = exopodite; Enp = endopodite): h. latero-external view; i. rostral view; j. latero-internal view. Scale: k = 50 µm (for figures a-g); l = 20 µm (for figures h-j)

1. Sympodite (Fig. 4a) has only 3 spines, distal one of which is distinctly large and 26% longer than others.

2. Thoracopods I-IV (not illustrated) are adult-like; last 4 thoracic segments have rounded sternum (in lateral view, Fig. 4c), the thoracopods V-VII being absent.

Abnormality: In one specimen, the right caudal furca with 5 spines (Fig. 4b).

Instar II: Sexually differentiated, 7 males, 2 females, Total length of male 0.62-0.81 mm, mean 0.72 ±0.06 mm (n = 7); of female 0.63-0.70 mm. Body and all appendages except thoracopods V-VII (Figs 4d-f) invariably bent posteriorly unlike thoracopods I-IV. Endopodite unsegmented, 0.7 times as long as basis; basis without inner seta. Thoracopods V and VI equal in size, Thoracopod VII somewhat longer. Exopodite cylindrical, shorter than endopodite, with 2 unequal terminal setae. Endopodite unsegmented, unarmed.

Thoracopod VIII (Fig 4g): Basipodite fused to protopodite and ending in large, sharply incurved hook-like spinous process; lateral seta absent. Outer lobe well-developed, conical in form. Dentate lobe undifferentiated, smooth, shorter than inner lobe. Exo- and endopodites not discernible.

Population variation: In the adults, the anal operculum varies widely in both sexes, and a similar trend is noticed in Thoracopod VIII female also. In one specimen, three aesthetascs were noticed on the fifth antennular segment – perhaps an abnormality. No variation is apparent in the number of spines borne by the sympodite of uropod.

Etymology: The new species is named in honour of Prof. H.K. Schminke, C.V.O. Oldenburg University, Germany, for his significant contributions to the study of Bathynellacea.

DISCUSSION

Schminke (1973) characterized the genus *Habrobathynella* as follows: antenna 2-segmented; labrum strongly vaulted, with 8 main teeth; mandible having, in place of "Borstenlobus", an outgrowth bearing 5 teeth. Maxilla 3-segmented, prehensile. Antennule 6-segmented, penultimate segment with 2 aesthetascs. Thoracopods with 2-segmented exopodite. Sympodite of uropod with a row of dissimilar spines, distal spine being thicker and longer.

The specimens under study closely fit the generic diagnosis. *Habrobathynella schminkei* sp. nov. appears to be somewhat closer to *H. milloti* than to *H. jeanneli*, as evident, *inter alia*, from the following features: antennules elongate, and apophysis of segment 4 shorter than the next segment; maxillule with six claws on distal endite; maxilla carrying two claws; setae on endopodite of uropod shorter than its tooth. However, the two species differ from each other as follows: labrum of new species less vaulted, proximal endite of maxillule bearing only three claws (two small, one large) and one setule, instead of four claws (three small, one large). In the uropod, distal spine on sympodite 44% shorter than endopodite (30% in *H. milloti*), exo- and endopodites constitute 34% and 86% of sympodite length respectively (42% and 65%, in *H. milloti*) and exopodite without spinous projection at inner terminal corner. Further, whereas the female Thoracopod VIII is well developed in *H. schminkei* sp. nov., it is "completely absent" in *H. milloti* (Delamare and Paulian 1954). The male Thoracopod VIII is also distinct in the two species. Its inner lobe in latero-internal view is triangular, reaching almost the same level as the basipodite in the new species, whereas it is rounded and higher than basipodite in *H. milloti* (see Delamare and Serban 1974); the nature and arrangement of denticles on the dentate lobe is different between the two taxa. Also, in the new species, the exopodite is much reduced in size and the endopodite (?) represented by a tiny triangular projection instead of a seta.

H. schminkei sp. nov. can be easily separated from both of its congeners by the following principal criteria: (i) one ventral plumose seta present at distal inner angle of sympodite of uropod; (ii) two strongly unequal setae on basal segment of maxilla; (iii) endopodite of uropod much elongated; (iv) female Thoracopod VIII large; (v) third endopodite-segment of thoracopods I-VII without seta; and (vi) setae on pleotelson shorter than caudal furca.

H. schminkei sp. nov. is also clearly distinguishable by some of its mandibular characters. *Pars molaris* as an outgrowth has five teeth in all, besides a proximal denticle, instead of only four teeth without a denticle. The proximal three teeth along with the denticle are more compactly arranged in a group than in the other taxa, and are also devoid of setules. The proximal tooth of *pars incisiva*, occurring at a somewhat higher level than *pars molaris*, cannot be said to be uniformly fused with *pars molaris* as in the other two species.

The author is of the opinion that the shorter pleotelson setae and the slight mandibular differences displayed by the new species are of consequence only at the species level [*cf* Schminke's (1973) generic diagnosis].

Habitat

The type locality of *H. schminkei* sp. nov. was rich in detritus at the time of sampling; the sand was fine and the current velocity moderate. The co-occurring fauna included: *Parastenocaris* sp. which was fairly common, followed by *Parastenocaris curvispinus* Enckell. Other copepods were represented by stray specimens of *Onychocamptus*

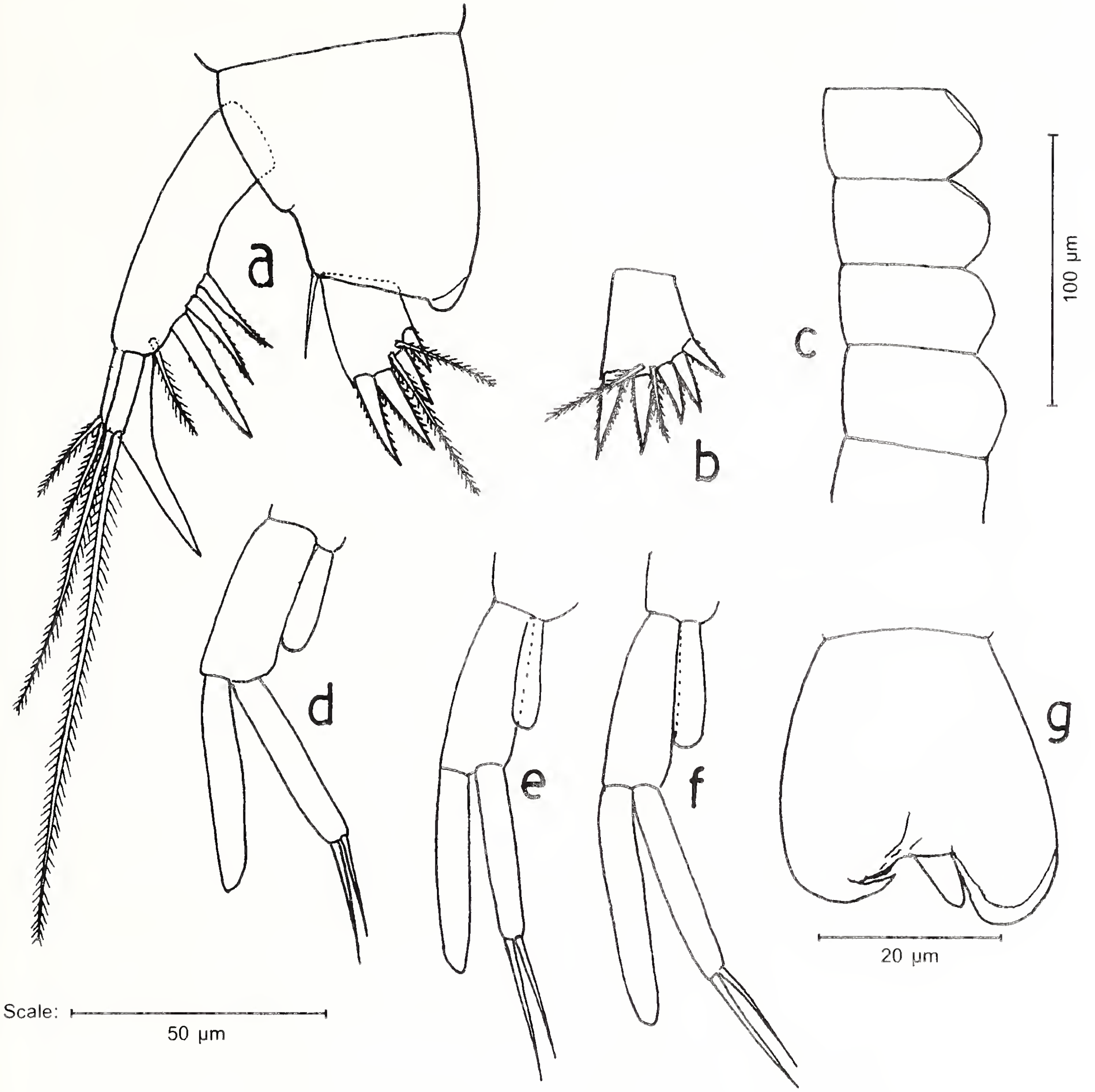

Fig. 4: *Habrobathynella schminkei* sp. nov., Instar I (as meant in the text). a. pleotelson, lateral view; b. abnormal right caudal furca, dorsal view; c. thoracic segments 5-8 (counted from above). Instar II (as meant in the text); d-g. thoracopods V-VIII, respectively. Scale: for figures a, b, d-f = 50 µm

chathamensis (Sars), *Elaphoidella* sp., *Nitokra* sp., *Eucyclops* sp., and *Paracyclops* sp. Unidentified ostracods were abundant. Among insects, mayfly nymphs were common along with *Chironomus* larvae. Nematodes were few.

Distribution

Outside its type locality, *H. schminkei* sp. nov. is known from the River Godavari at Rajahmundry. It was noticed in January at both the localities. It is likely to be found in other peninsular rivers as well, but may not be frequent. In the River Krishna, however, it is apparently replaced by *Habrobathynella indica* Ranga Reddy and Schminke.

This discovery of the genus *Habrobathynella* in South India fills the long-existing and large gap in the distribution of Bathynellacea. It also further testifies to the East Asian origin of the Family Parabathynellidae (Schminke 1974).

Conclusion

The hyporheic and phreatic environment of South Asia with its diversified geomorphology, hydrography and climate, is quite likely to support a rich faunal diversity as elsewhere (Pesce 1985). However, little is known about this special habitat. Hence stygobiological research in this region is bound to be rewarding.

Addendum

Since the acceptance of this manuscript of this paper for publication, the following two species have been added to the genus *Habrobathynella*: *H. nagarjunai* Ranga Reddy, 2002 (see *Hydrobiologia 470*: 37-43, 2002) and *H. indica* Ranga Reddy & Schminke (*J. nat. Hist.* in press)

ACKNOWLEDGEMENTS

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Journal of the Bombay Natural History Society, 101 (2), May-Aug 2004 285-287

A NEW SPECIES OF *USCANA* GIRAULT (TRICHOGRAMMATIDAE: HYMENOPTERA) FROM THE EGGS OF FIELD BRUCHIDS[1]

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A new parasitoid *Uscana bruchidiusi* on the eggs of four species of *Bruchidius*, namely *B. pygomaculatus*, *B. saundersi*, *B. aureus*, *B. multilineolatus*, all attacking *Albizzia lebbek* in the field, has been described. A key to the known Indian species of genus *Uscana* is also given.

Key words: *Uscana bruchidiusi* sp. nov., *Bruchidius pygomaculatus*, *B. saundersi*, *B. aureus*, *B. multilineolatus*, *Albizzia lebbek*

INTRODUCTION

Uscana Girault is a small genus of Trichogrammatidae (Girault 1911; Dout and Viggiani 1968) and includes about 20 species, which are mostly associated with the eggs of different bruchid beetles (Mani 1935; Viggiani 1979; Fursov 1987; Huis *et al.* 1991; Pajni and Sood 1999). Only two species have so far been recorded from India i.e. *Uscana mukerjii* (Mani) from the eggs of stored product pest bruchids and *Uscana femoralis* Pajni and Sood from the eggs of *Conicobruchus albopubens* (Pic.) attacking *Cyamopsis psoraloides* DC. A third species has been found attacking the eggs of four species of genus *Bruchidius*, namely *B. pygomaculatus* Arora, *B. saundersi* (Jek.), *B. aureus* Arora, and *B. multilineolatus* Arora, all of which attack the green seeds of *Albizzia lebbek* Benth. Incidentally, only the above mentioned three species have been recorded from the Oriental region, with the remaining 17 known species having been recorded from Palaearctic and Nearctic regions. The present species, though distinct from all described species, shows resemblance with *Uscana mukerjii*, as both fall in the same group of species formulated on the basis of arrangement of placoid sensilla in the club of the antenna (Steffan 1954; Pajni and Singh 1973).

OBSERVATIONS

The Family Trichogrammatidae can be distinguished from other families of Superfamily Chalcidoidea by the presence of 3-segmented tarsus without a stergil on the foretarsus and broad forewing with marginal and stigmal veins forming a single curve. Genus *Uscana* can be separated from other genera of Trichogrammatidae by a combination of characters including antenna with one or two annulets, 4-segmented antennal club with placoid, fungoid and chaetoid sensilla, straight and thickened marginal vein and stigmal vein with a constricted neck. The distribution of placoid sensilla on the female antennal club separates different species.

KEY TO THE SPECIES OF GENUS *USCANA*

1. Male with hind femora normal 2
— Male with hind femora swollen ..... *femoralis* Pajni & Sood.
2. Female antennal club with placoid sensilla formula 2:1:0:1 .... *mukerjii* (Mani)
3. Female antennal club with placoid sensilla formula 2:1:2:2 .... *bruchidiusi* sp. nov

***Uscana bruchidiusi* sp. nov** (Figs 1-7)

Description

Female: Body short, flat, length 0.30 to 0.42 mm. Head and thorax pale yellow, abdomen slightly darker than other body parts; legs pale, becoming lighter at apices; eyes and ocelli crimson red, head almost as long as wide in front view, not wider than thorax. Mandibles quadridentate. Pedicel 1.45 times as long as wide; annulets two, normal; antennal socket with its upper margin at much higher level than lower margin of eye; club 3.2 times as long as its greatest width at first segment, with placoid sensilla 2:1:2:2, its fourth segment pointed apically, with sides of the first segment 1.5 times as long as second segment; eyes asetose.

Mesoscutum 1.56 times as wide as long, with two pairs of short setae, with finely reticulate sculpture and stripe of long reticulations in middle. Scutellum 2.2 times as wide as long. Postphragma reaching abdominal tergite IV, almost equal to length of mesonotum; scutum and scutellum 53:50.

Forewing twice as long as its greatest width; fringe about 0.24 of greatest width of wing; costal cell 1.84 times as long as marginal vein and 2.2 times as long as wide, with 3 costal setae, 5 dorsal and 3 ventral hairs; discal setulae and veinlets obscure. Hindwing about 6.75 times as long as its greatest width, its fringe 1.31 times the greatest width of free membrane.

Abdomen 1.69 times as long as thorax; Ovipositor not protruding, almost equal to length of midtibia (47:48).

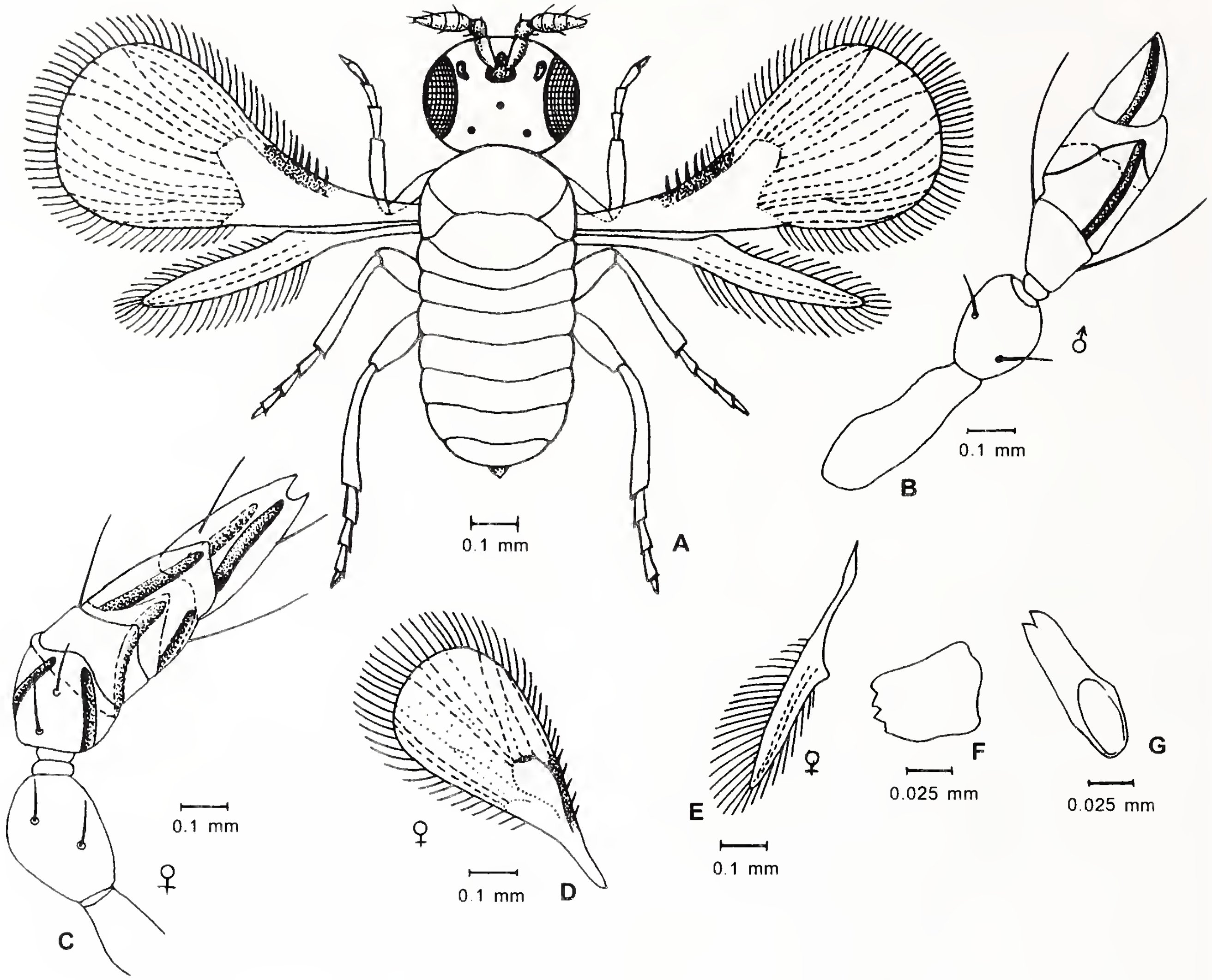

Fig. 1: *Uscana bruchidiusi* sp. nov.;
A. Male; B. Antenna male; C. Antenna female; D. Forewing female; E. Hindwing female, F. Mandible female,
G. Genitalia male

Male: Length 0.30 to 0.46 mm. Pedicel 1.20 times as long as wide; antennal annulets 2; club 2.4 times as long as its greatest width at first segment and 1.6 times as long as segments 1 and 2 combined, with second and fourth segments subequal; distribution of placoid sensilla 0:1:0:1.

Forewing 2.25 times as long as its greatest width, with fringe one third of its greatest width; discal setulae arranged in 17 rows, with 14 of them uniform. Hindwing 6.92 times longer than its greatest width; fringe 0.65 times the greatest width of free membrane. Male genitalia with phallobase 2.92 times as long as wide.

Material: Holotype: Male, from eggs of *Bruchidius pygomaculatus*, *B. saundersi*, *B. aureus* and *B. multilineolatus* attacking seeds of *Albizzia lebbek* Benth (Sarin) Coll. P.K. Tewari, 16.ix.1999; Chandigarh. Paratypes: 6 males, 4 females; collection data same as holotype. Type material in Entomology Section, Department of Zoology, Panjab University, Chandigarh; under Accession No. 138.

Distribution: Shivalik forest area near Chandigarh and Chandigarh-Mullanpur road.

Biology: The species, in nature, attacks the eggs of four species of *Bruchidius* infesting *Albizzia lebbek* in the wild. However, it is capable of parasitising the eggs of *Callosobruchus maculatus* (Fab.) in the laboratory and is being exploited for accepting the eggs of stored product bruchids as its host.

Etymology: The species has been named after its host *Bruchidius*, four species of which are attacked by the egg parasitoid.

Discussion: The new species is different from both *U. mukerjii* and *U. femoralis* as its body is entirely pale yellowish, compared to the black body of *U. mukerjii* and partly black body of *U. femoralis*. Taxonomically, the new species is close to *U. mukerjii* as the first segment of the female club in both the species carries two placoid sensilla. This is according to the classification of *Uscana* species by Steffan (1954), extended by Pajni and Singh (1973). Furthermore, *U. femoralis* is distinct in having characteristic greatly swollen hind femora in the male.

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A NEW SPECIES OF SPIDER OF THE GENUS *PEUCETIA* THORELL (OXYPOIDAE: ARANEAE) FROM DIGHA, MIDNAPORE, WEST BENGAL, INDIA[1]

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One new species, *Peucetia gauntleta* recorded from Digha, Midnapore is described and illustrated.

Key words: Spider, Oxyopidae, *Peucetia gauntleta* sp. nov., Digha, Midnapore, West Bengal

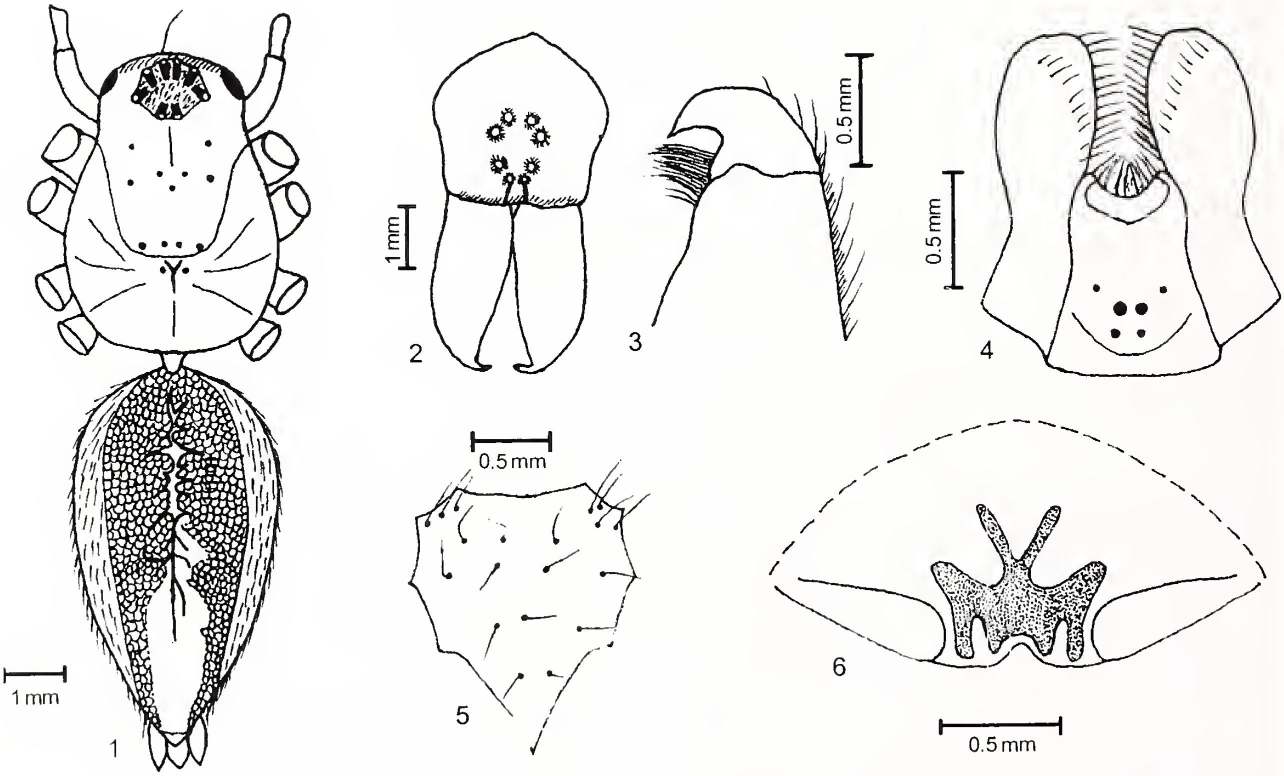
INTRODUCTION

Recently, Gajbe (1999) reviewed the taxonomy of the poorly known oxyopid spiders of India. He dealt with 20 *Oxyopes* spp. and 10 *Peucetia* spp. Of these, 6 of the *Peucetia* spp. were recognised as new to science. Earlier, Biswas (1975), Gajbe (1992), Pocock (1900) and Tikader (1965, 1970) studied the genus *Peucetia*.

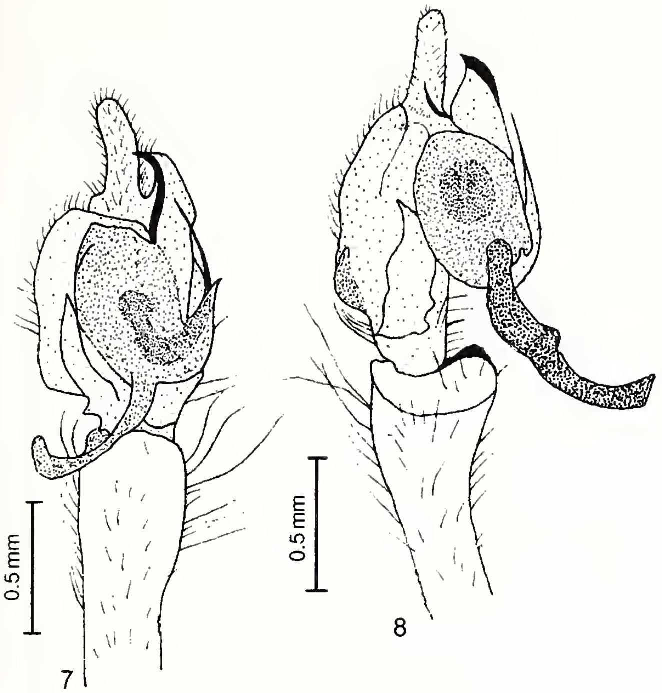
With the present species, the genus *Peucetia* in India is now represented by 14 species. The new species is described and illustrated.

MATERIAL AND METHODS

The spider sample was collected and preserved following Tikader (1987). The study was made using Stereo Zoom Binocular Microscope, Model Zeiss SV-8. The measurements indicated in the text are in millimetres, made with an eyepiece graticule.



Figs 1-6: *Peucetia gauntleta* sp. nov. ♀ Holotype,
1. Whole body, dorsal aspect; 2. Cephalothorax and chelicerae (Frontal aspect); 3. Chelicera, frontal aspect;
4. Maxillae & Labium, ventral aspect; 5. Sternum, ventral aspect; 6. Epigynum, ventral aspect



Figs 7-8: *Peucetia gauntleta* sp. nov. ♂ Allotype, 7. Male palp, ventral aspect; 8. Male palp, lateral aspect

Peucetia gauntleta sp. nov. (Figs 1-8)

Measurements (in mm): ♀ Total length: 12.13; Carapace length: 5.06, width 3.53; abdomen length: 6.40, width 3.33; legs as in Table 1.

Cephalothorax: Pale green with cephalic region tinted with grey, sparingly spotted with brown, longer than wide, anteriorly narrow, posteriorly broad; cephalic region raised, sloped anteriorly, cephalic furrow deeply impressed; thoracic region medially with longitudinal fovea, radii distinct. Eyes black, each ringed with silky white pubescence, anterior-most eyes smallest, anterior row of eyes recurved, posterior row procurved; ocular area blackish. Clypeus with a pair of black bands extending from anterior-most eyes to the basal margin of chelicerae. Chelicerae pale yellow-green, robust, elongate, basally broad, sparingly spotted with brown, each with erect, short to long spiny hairs; fangs reddish-brown, curved, margins devoid of teeth. Maxillae and labium similar to chelicerae in colour, elongate, former anteriorly broad, latter little narrower than base, both anteriorly scopulate. Sternum pale yellow-green, heart-shaped, with sparse brown spots that include short to long spiny hair. Legs yellow with coxae yellow-green, each femur with brown spots; leg formula 1243.

Table 1: Length of legs of ♀ holotype of *Peucetia gauntleta* sp. nov. (in mm)

Leg	Femur	Patella	Metatarsus	Tarsus	Total
I	6.33/6.32	1.33/1.33 + 6.15/6.16	5.66/5.65	3.16/3.17	22.63/22.63
II	5.67/5.66	1.33/1.33 + 5.50/5.51	5.17/5.16	2.66/2.65	20.33/20.31
III	4.66/4.65	1.33/1.33 + 4.00/4.00	4.00/4.01	1.83/1.83	15.82/15.82
IV	4.83/4.83	1.33/1.33 + 4.16/4.15	4.33/4.32	1.66/1.67	16.31/16.30

Abdomen: Green, elongate, oval, posteriorly narrow, decorated as in Fig. 1, clothed with short to long silky white hairs and spines, some originating from the brown spots; venter similar to dorsum clothed with silky white hairs. Epigyne as in Fig. 6.

Male: Cephalothorax greyish-yellow, larger than abdomen. Abdomen green, slender. Legs much longer than female; otherwise as in ♀.

Material examined: Holotype ♀, Allotype ♂, Midnapore, Digha, 15.ix.2000, Coll. S. Saha

Type deposition: Department of Zoology, Lady Brabourne College, Kolkata. Regn No. LBC/DZ/1/01.

Distribution: India: West Bengal, Midnapore, Digha.

Remarks: The present species *Peucetia gauntleta* sp. nov., because of clypeus with 2 lateral lines and abdomen with mid-dorsal silvery white patches, but without stripes, resembles *P. ketani* Gajbe (Gajbe 1999), but differs in having a distinct decoration at the basal half of the green abdomen, which is devoid of a black patch, heart-shaped sternum and very different epigyne. *Peucetia gauntleta* sp. nov. also resembles *P. latikae* Tikader (Tikader 1970) in the structure of the epigynum and male palp, but has only 2 black lines on clypeus and absence of broad abdominal band. These characteristics justify its status as a new species. Furthermore, none of the other congeners bear significant resemblance to *P. gauntleta*. The species is therefore recognised as new to science.

Etymology: The species is so named because of the glove-like maxillae.

ACKNOWLEDGEMENTS

The first author (S.S.) is grateful to the D.P.I., Education Department, Govt. of West Bengal and the Principal, Lady Brabourne College, Kolkata for permission to conduct a study tour at Digha, Midnapore. Heartfelt thanks are due to all the colleagues and 2nd year Zoology Honours students for their kind cooperation in the matter of collection.

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Journal of the Bombay Natural History Society, 101 (2), May-Aug 2004 **291-293**

BRACHIARIA MARSELINI SP. NOV. A NEW SPECIES OF POACEAE FROM MAHARASHTRA[1]

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Genus *Brachiaria* (Trin.) Griseb. (Poaceae) consists of about 90 species distributed in warm regions, generally in Africa and Asia, with the exception of one European species. In India, there are about 20 species and 7 infraspecific taxa, of which 7 species are represented in Maharashtra. The authors have collected an undescribed species from Malvan in Sindhudurg District, Maharashtra, belonging to genus *Brachiaria* and described herein.

Key words: *Brachiaria*, Panicoidae, Poaceae, Malvan, Maharashtra, Sindhudurg

During a floristic survey on flowering plants of Malvan taluka, Sindhudurg district, Maharashtra, in September 2000, we came across a patch of interesting grass under the shade of a tree, on the bank of a stream. A few plants were collected from the area, processed and preserved in the Blatter Herbarium and later assigned to the genus *Brachiaria* Griseb. Comparison with material deposited at Blatter Herbarium (BLAT) and literature at the BLAT library (Almeida 1990; Blatter and McCann 1935; Bor 1960; Cooke 1903-1908; Dalgado 1898; Hooker 1872-1897; Kulkarni 1988; Karthikeyan *et al.* 1989) confirmed it as a new species of the genus *Brachiaria* Griseb., Family Poaceae, and was named *Brachiaria marselini* sp. nov. The new species is very closely allied to *Brachiaria ramosa* (Linn.) Stapf. in external morphology, but differs in the following characters:

Species similis *Brachiaria ramosibus* differet tamen

Habitus annualis gracilis. Axis inflorescentia 2-4 ramus. Superus glumae planus.

Holotype: N.D. Gawade 1442 - Masure - Malvan, Sindhudurg, 27.ix.2000 (BLAT)

Isotype: N.D. Gawade 1445 - Masure - Malvan, Sindhudurg, 27.ix.2000 (BLAT)

A detailed description of the plant, along with floral peculiarities, is provided in the text.

A prostrate annual runner, 20-30 cm tall, rooting at nodes; roots 2-3, mostly arising from the basal node, slender, thin, narrow, 1.5-6 cm long, giving out lateral roots at some distance. Stem slender, covered by sheathing petiole; grooved, striate, hairy on the ventral surface; hairs short, brown, erect, closely arranged on the edges of the stem. Internodes 3-3.2 cm long, ensheathed by petiole. Leaves linear-lanceolate, up to 7 cm, 0.5-0.6 cm long, excluding the petiole. Petiole 2-2.1 cm long, striate, brownish-hairy on the margins, slightly constricted at the joint with the lamina; hairs longer than the hairs of the stem, arising in clusters below the junction of the petiole, telescopic. Lamina slightly curved at the base towards one side; mid-vein of the lamina prominent, lateral veins interspersed with 4 stronger parallel veins, running parallel from the base to the apex, base of the lamina rounded, one portion of the lamina slightly overlapping at the base with the other. Petiole hollow. Hairs present at the junction of the lamina, and petioles of two types, of which one type occurs in clusters and the other spreads on the edges of the petiole. Mid-vein of lamina very prominent, continues with mid-vein of petiole on the lower surface. Ligule U-shaped, situated at the junction of the lamina and the petiole, where it is slightly grooved and hairy, hairs brown, linear, unicellular, slightly curved at the apex. Inflorescence terminal panicle, about 10 cm long, with 4-5 branches, holding distantly arranged spikelets on a green, slender, striate ribbed rachis somewhat grooved in the middle, arising from the axil of a leaf. Spikelets in pairs, one stalked and the other almost sessile to the naked eye, 8 mm long; outer bracts 2, small, ensheathing the flowering glume, forms a V shape at the base. Lower involucral glume 4 mm long, more or less equal in length of the flowering glume, ovate, acuminate, 3-nerved with a prominent mid-nerve. Upper involucral glume 4.5 mm long, 6-nerved, light green, membranous. Lower floral glume 4 mm long, 5-nerved, acuminate; upper floral glume 3-nerved, 4 mm long, acuminate; palea of upper floral glume ovate, acute, 3.5 mm long.

Male spikelet with 3 stamens, filament white, slender; anthers dark yellow, divaricate at both ends. Pollen grains rounded, 2-porate, exine smooth, intine pinkish; lodicule one, oval-shaped fleshy, situated at the base of the lemma. Inner floret bisexual, consisting of 3 stamens; anthers long, golden yellow when mature, divaricate at both ends, filaments slender, white. Gynaecium with superior, white, ovate ovary; style 2-partite from the base; stigma 2, plumose, free. Caryopsis globose with short acute apex, testa of caryopsis 3-4 veined, ovule anatropous, prominent, fleshy.

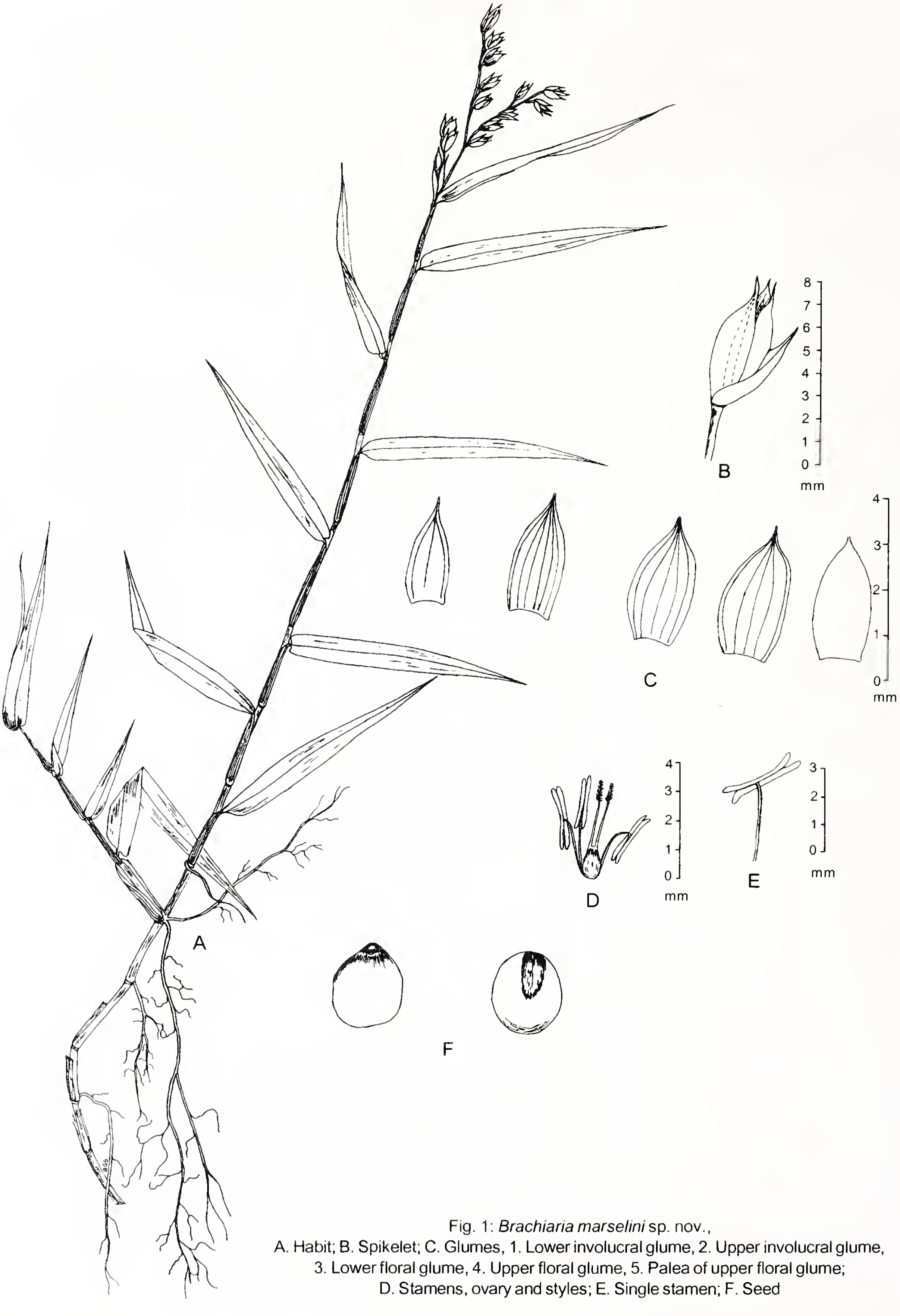
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Fig. 1: *Brachiaria marselini* sp. nov.,
A. Habit; B. Spikelet; C. Glumes, 1. Lower involucral glume, 2. Upper involucral glume, 3. Lower floral glume, 4. Upper floral glume, 5. Palea of upper floral glume; D. Stamens, ovary and styles; E. Single stamen; F. Seed

Table 1: Differences between *Brachiaria marselini* sp. nov. and *B. ramosa* (Linn.) Stapf

Brachiaria marselini sp. nov.		*Brachiaria ramosa* (Linn.) Stapf.	
1.	Slender annual.	1.	Stout annual.
2.	Internodes 2-2.2 cm long, nodes covered by sheathing leaf base, which is hairy all over the edges. Hairs short, erect, standing in the form of toothbrushes, many at the juncture of the node.	2.	Internodes 8-10 cm long, distinctly ribbed; constricted narrowly, short, white, wooly hairs all around. Sheathing leaf base slightly auricled, hairy, hairs of two types, long and stiff hairs at the base on both sides and short hairs in the middle.
3.	Leaves linear-sagittate, terminating in a long acuminate apex. Lamina curved at base, hairy on one side, hairs brown.	3.	Leaves linear; leaf margins wavy, undulate, thick, with stiff hairs on ventral surface.
4.	Mid vein thick, prominent, lateral veins faint, lamina. punctate all over. Margin with prominent spicules slightly curved upwards (visible under microscope).	4.	Veins parallel, of two types, 4-5 stronger veins alternating with thinner veins, lamina hairy; spicules inconspicuous.
5.	Panicle terminal with 2-4 branches.	5.	Panicle terminal with 8-10 branches.
6.	Spikelets and rachis not hairy.	6.	Spikelets with 2-3 erect hairs at apex of short stalk.
7.	Lower involucral glume more or less equal in length to the lower floral glume.	7.	Lower involucral glume 1/2 as long as lower floral glume.
8.	Upper involucral glume with plain surface	8.	Upper involucral glume cuspidate
9.	Upper floral glume plain	9.	Upper floral glume scrobiculate.
10	Anthers divaricate at both ends	10.	Anthers linear, straight.

Brachiaria marselini sp. nov. is illustrated here (Fig. 1) to clearly show the peculiar features of the species.

Holotype: N.D. Gawade 1442 - Masure - Malvan, Dist. Sindhudurg, 27.ix.2000 (BLAT)

Isotype: N.D. Gawade 1445 - Masure - Malvan, Dist. Sindhudurg, 27.ix.2000 (BLAT)

The material has been deposited at the Blatter Herbarium, St. Xavier's College, Mumbai.

Etymology: This species is named after Prof. (Dr.) Marselin R. Almeida D.Sc., as a mark of respect for his contribution to the field of Plant Taxonomy, especially of Maharashtra, western India and his ever-willing help to anybody who approaches him for identification of plants.

ACKNOWLEDGEMENT

The authors are extremely grateful to Dr. (Mrs.) S.M. Almeida, Director, Blatter Herbarium, for guidance and help rendered in the preparation of this article.

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A NEW SPECIES OF *SPIRULINA* (= *ARTHROSPIRA*) *MAHAJANI* MAHAJAN FROM KHARGONE, MADHYA PRADESH[1]

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Spirulina (= *Arthrospira*) has received great commercial impetus in recent times and this has resulted in the publication of many papers on the physiology, methods of cultivation, mass production etc. Most publications generally refer to this alga as *Spirulina platensis*. Desikachary and Jeeji Bai (1996) have grouped the various strains and natural samples of this alga under four distinct taxonomic entities and assigned them to 1. *A. indica*, 2. *A. maxima*, 3. *A. massartii* and 4. *A. platensis*. The genus *Spirulina* is characterized not only by coiled trichomes, but also by differences in the coiling pattern. Besides the usual differences in trichomes and cell dimensions, the cell morphology provides a very important consistent and reliable feature which is observed in all the four groups. Groups 1 and 4 show a greater degree of attenuation than groups 2 and 3. The Khargone specimen belongs to group 4, but it differs from its other strains by the narrower trichomes with calyptrate end cells. The Khargone material shows a calyptra and somewhat narrower trichomes and is hence not included in this group. On account of its separate entity, it has been assigned a new name *Spirulina mahajani* Mahajan.

Key words: *Spirulina, Arthrospira*, natural samples, identification, taxonomic criteria, new report, blue-green algae

The planktonic alga described was collected from a temporary pond at the Government P.G. College, Khargone (21° 45' N, 75° 37' E, 250.38 m above msl) during November-December, 1990, mixed with *Oscillatoria*, *Hydrodictyon*, *Sirogonium*, *Spirogyra* and diatoms. The depth of the pond was 90 cm. Turbidity of the stagnant water was 20 NTU, pH 7.6 and water temperature was 28.3 °C, when the algal sample was collected at 1400 hrs.

Trichomes 4.9-5.6 µm broad in the middle and 3.4-5.1 µm at the ends; Cell length 2.1-3.6 µm; end cells rounded, non-capitate but calyptrate; number of coils 3-5; coil diameter 33-44 µm in middle and 33-39 µm at the ends; Pitch of coil 39-99 µm; percentage attenuation 5-20 (Fig. 1).

Material collected from Khargone pond differs from all the known species of *Spirulina*. Desikachary and Jeeji Bai (1996) have emphasized on a separate entity. Hence, the material is a species new to science. The epithet *mahajani* is suggested (after the name of author who collected the material) for this new species (Table 1).

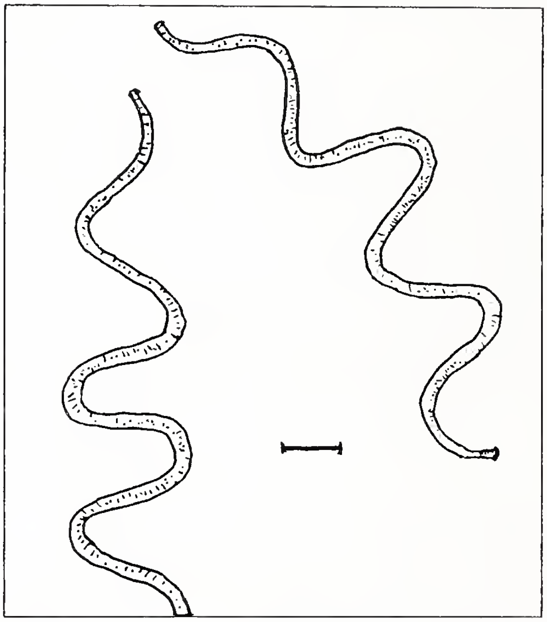

Fig. 1: Regularly coiled, narrow trichomes with calyptrate end cells (Scale: 20 µm)

Table 1: Comparison of dimensions of *S. mahajani* sp. nov. with allied species of *Spirulina* (=*Arthrospira*). [All dimensions are in µm] (Desikachary and Jeeji Bai 1996)

S. No	Strain/sample	No. of coils	Coil diameter		Pitch of coil	Trichome diameter		% attenuation	Cell length	End cell
			mid	end		mid	end			
1.	*Arthrospira platensis*	-	26-36	-	43-57	6.0-8.0	-	Slight	2.0-6.0	Rounded
2	*Arthrospira platensis* var. *californica*	5-12	33-44	22-33	66-77	7.8-9.0	5.6-7.0	20-35	3.4-4.2	Broadly rounded
3.	*Spirulina mahajani* sp. nov.	3-5	33-44	33-39	39-99	4.9-5.6	3.4-5.1	5-20	2.1-3.6	Rounded/calyptrate

The material and slide have been deposited with the Botany Department, Government P.G. College, Khargone for record. Regn. No. PGDB 390.

I extend my sincere thanks to Dr. P.L. Jain, Principal and Prof. P.R. Paliwal for encouragement and facilities.

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A NEW SPECIES OF THE BLIND FISH *HORAGLANIS* MENON (SILUROIDEA: CLARIIDAE) FROM PARAPPUKARA (TRICHUR DISTRICT) AND A NEW REPORT OF *HORAGLANIS KRISHNAI* MENON FROM ETTUMANUR (KOTTAYAM DISTRICT), KERALA[1]

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Horaglanis alikunhii – a new species of blind fish of Family Clariidae (Siluroidea) is described from Trichur district, Kerala. *Horaglanis krishnai* Menon is newly reported from Ettumanur, Kottayam district, Kerala.

Key words: *Horaglanis alikunhii* sp. nov., blind fish, *Horaglanis krishnai*, new record, endemism

INTRODUCTION

The genus *Horaglanis* was created by Menon (1950) to include a siluroid fish obtained from a well at Kottayam, Kerala. The unique character of this fish was the complete absence of eyes. This was the first report of a totally blind fish from India. On May 15, 2000 we obtained a blind fish at a depth of 8.5 m, while digging a new well in the void laterite soil of Parappukara (10° 23' N, 76° 15' E), Trichur district, Kerala. The fish was collected live from a narrow crevice on the sidewall of the well through which water was flowing out. The live fish was translucent with visible blood capillaries, so that the fish appeared a beautiful red. It was kept alive in an aquarium along with some other fish until September 22, and subsequently preserved in 8% formaline for further study. On April 1, 2001 we collected another blind fish from a well at Ettumanur (Kottayam district) while pumping out water.

The morphology of both the fishes was studied in detail under a stereomicroscope without dissecting them. The specimen obtained from Ettumanur was easily identified as *Horaglanis krishnai* Menon by comparing it with the original description by Menon (1950), and with those of Jayaram (1981) and Talwar and Jhingran (1991). However, the specimen collected from Parappukara was found to be distinct and is described here as a new species of *Horaglanis* Menon.

Horaglanis alikunhii sp. nov. (Fig. 1)

Description: Body elongate, eel-like, total length 3.2 cm , its maximum height just behind the head. Head with four pairs of barbels characteristic of Family Clariidae; eyes completely absent. Gill membranes united at the anterior end near the lower jaw. Dorsal fin long, with 24 rays arising in advance of the origin of pelvic fins; anal fin with 17 rays originating far behind the origin of pelvics; both dorsal and anal fins terminating at base of caudal fin. Pectoral fins minute, highly vestigial, leaf-like, with rounded margin, supported by short central axis and 9 rays; pelvic fins long, conspicuous, supported by 6 rays, 2nd ray distally branched. Caudal fin large with pointed tip, supported by 30 rays, middle 10 rays branched at their ends.

Holotype: The specimen is deposited with the Zoological Survey of India, Calicut. Regn. Code: ZSI (WGRS) CLT. No. V/F 13137.

Etymology: The species is named after the distinguished aquaculturist Dr. K.H. Alikunhi in appreciation of his contribution to fishery science in general and Indian fisheries in particular.

Relationship: *Uegitglanis* Gianferrari and *Horaglanis* Menon are the only known genera of Family Clariidae in which the eyes are absent. Both these genera are similar in the elongated shape of the body, disposition of dorsal and anal fins terminating at the base of the caudal and in the complete absence of eyes. However, *Horaglanis* is distinguished from *Uegitglanis* in having relatively shorter dorsal and anal fins, vestigial pectoral fins without spines and gill membranes united with the isthmus. A comparison of the specimens obtained by Menon (1950) from Kottayam, and the present specimens collected from Ettumanur and Parappukara is given in Table 1. Although the Ettumanur specimen is very similar to the one from Kottayam, the specimen from Parappukara, namely *H. alikunhii* differs as shown in Table 1.

Ecological Notes: Both, *Uegitglanis zammaroni* Gianferrari 1923 obtained from Italy (Teugels 1996) and *Horaglanis krishnai* Menon 1950 from Kerala are considered

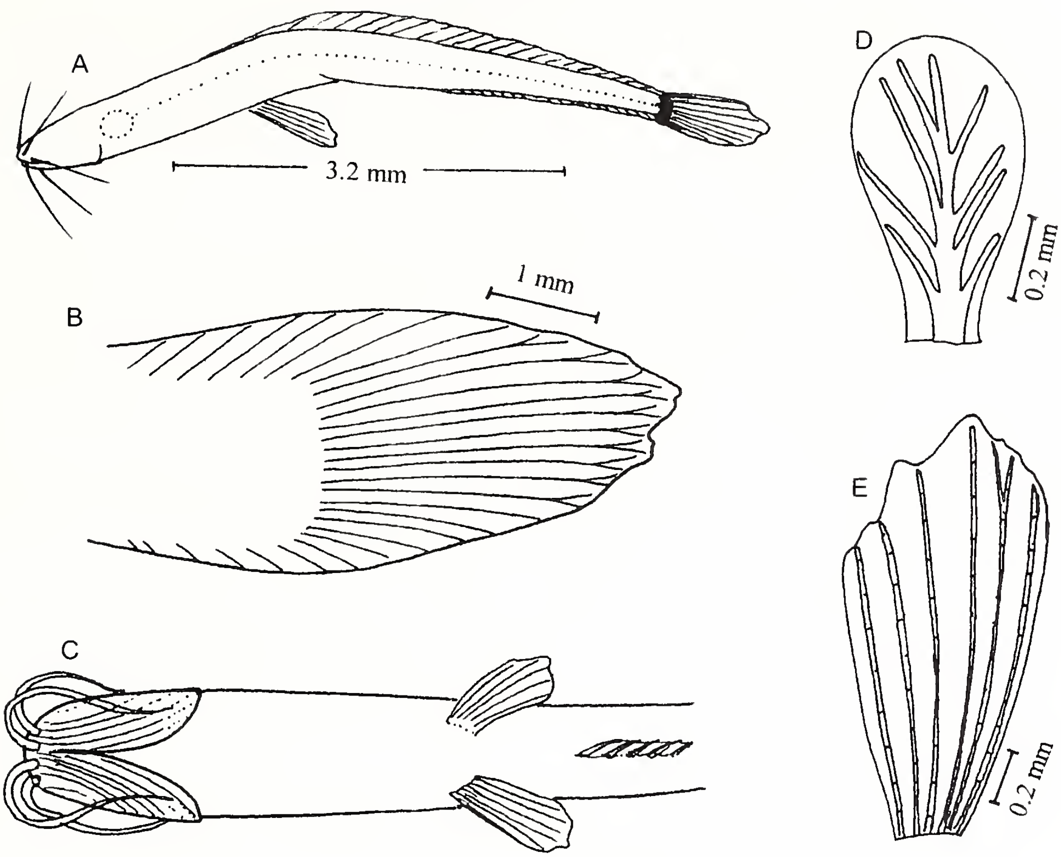

Fig. 1: *Horaglanis alikunhii* sp. nov., A. Lateral view; B. Caudal fin; C. Ventral view (anterior half only); D. Pectoral fin; E. Pelvic fin

Table 1: Comparison of characters of *Horaglanis alikunhii* with *H. krishnai*

Characters	*H. krishnai* Kottayam	*H. krishnai* Ettumanur	*H. alikunhii* Parappukara
Total length	38.85 mm	39.00 mm	32.00 mm
Length of head	6 mm	5.5 mm	6 mm
Width of head	5.8 mm	4.5 mm	3.5 mm
Length/Width ratio of head	1.035	1.22	1.71
Shape of head	Globular	Globular	Elongated
Number of dorsal fin rays	23	23	24
No. of anal fin rays	17	17	17
Pectoral fins	Vestigial	Vestigial	Highly vestigial
Pelvic fins	Normal	Normal	Long, well developed
Caudal fin shape	Margin rounded	Margin rounded	Pointed tip
Caudal fin rays	24	24	30
Colouration	Yellowish-white (preserved)	Red when alive	Red when alive
Habitat	Well	Well	Subterranean channel

cave-restricted blind species, although they are found to occur in wells. It is noteworthy that *Horaglanis alikunhii* from Parappukara was collected live from a narrow crevice on the sidewall of a well through which water was flowing. This indicates its subterranean habit and that it might have reached the site through interconnected cavities in lateritic rocks. The presence of a hypogean fish population in these channels shows the existence of a unique ecosystem. The red colour of the live fish due to the abundance of erythrocytes in the superficial blood capillaries is probably an adaptation in oxygen-deficient waters in this habitat.

Endemism: The first report of *Horaglanis krishnai* was from a well at Kottayam (locality not mentioned) in 1950. Subsequent reports of this species by Mercy *et al.* (1982) and Mercy *et al.* (1984) are also from wells at Kottayam. The locality at Ettumanur from where the collection was made is only about 12 km from Kottayam town. As *H. krishnai* is known only from Kottayam district, it can be considered endemic to this region. Because of its endemic distribution, scarcity of available specimens and the unique habitat subject to destruction, *H. krishnai* is included in the Red List of threatened animals by IUCN (1990).

ACKNOWLEDGEMENTS

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REVIEWS

1. MALARIA IN THE THAR DESERT: FACTS, FIGURES AND FUTURE by B.K. Tyagi, 2003. Published by Agrobios (India), Jodhpur. 165 pp (22 x 14 cm), 14 B/W figures, 8 colour plates. Price Rs. 495/-; US $ 33.

The fragile desert ecosystem of the Thar in Rajasthan has been greatly affected by the Indira Gandhi irrigation system. Environmentalists know that extensive water logging and salinisation of the soil has occurred, and that desert fauna and flora are being replaced by invasive species from outside. It is not so well known that irrigation also brought malaria and its vectors. Dr. Tyagi has worked in the area for many years, and this is the subject of his monograph.

The Thar desert was for years considered an area with minimal problems, where sporadic and infrequent focal outbreaks of *vivax* malaria occurred and no deaths were reported. The mosquito vector, *Anopheles stephensi*, bred in domestic underground water storage containers characteristic of the rural areas of the Thar Desert, called *tanka*. These hold rainwater, or are replenished by the villagers from sources that might be 20-30 km distant. Similar pits called *beri* are dug in the bed of seasonal ponds, to hold rainwater. Over the past two decades, additional breeding sites have become available in the form of seepage water from the main canals, and faulty and badly maintained water channels. Outside Jodhpur, flooded mine pits provide ideal breeding grounds. Twelve species of *Anopheles* have now been recorded, where previously only one hardy species could survive. This has been facilitated by the change in microclimate, chiefly increased humidity, which has increased longevity. Several potential malaria vector species have established themselves, of which *A. culicifacies*, *A. stephensi* and *A. subpictus* have been incriminated by dissection as malaria vectors. *A. stephensi* was still the most effective vector, with highest longevity and highest infectivity rates, but *A. culicifacies* is probably playing the most important role simply because of its very high population density.

Until the mid-eighties, incidence of malaria was considerably lower in the desert districts of Rajasthan than in non-desert districts. Since then there has been a steady increase, and in 1990 and 1994 incidence in the desert was about twice that in the other districts. Worse still, the proportion of cases due to *falciparum* malaria has increased, and deaths have occurred during epidemics, particularly in 1994. In the flood-prone Barmer district, explosive epidemics take place, and subside over one or two years. In areas irrigated by the Indira Gandhi Canal, epidemics may take several years to spread, and show little tendency to subside. Dr. Tyagi documents these changes in detail, and relates them to ecological and epidemiological factors. He has done a commendable job of interpretation, much of it based on studies made by him and his colleagues over more than a decade. This monograph is a case study of man-made irrigation malaria in the desert ecosystem. It is extremely useful to have this information in a compact volume, and particularly to have the earliest reports from the region in this accessible form. One wishes that there were similar monographs for other problem areas in India.

However, there are lacunae in the book. *A. stephensi*, the species best adapted to desert conditions, is known to have three ‘varieties’, characterised by the number of ridges on their eggs. While Dr. Tyagi presents interesting data on morphological variation among adult females in his area, he has neither examined the eggs nor sent material for cytological examination, thus missing out on an opportunity to relate his work to what is known elsewhere in the country about taxonomic status and bionomics. His section on control is disappointing. While we are given the history of control operations and insecticide resistance in the area, no attempt is made to critically examine the technologies available to deal with the present situation. The author tells us that he has developed a mosquito-proof *tanka* cover. We would like to know much more about this practical and potentially useful tool. He has also tested insecticide-treated bed-nets and various biological control agents, but does not comment on their appropriateness or cost-effectiveness. As a specialist on Odonata, he suggests the use of dragonflies as biological control agents. But, though dragonfly nymphs consume mosquito larvae voraciously, the adults will not mate in captivity, and therefore forced mating would be necessary to obtain sufficient nymphs for practical control, and this does not seem feasible.

What is urgently required is an engineering solution. Although expert committees have been talking for years about inter-sectoral coordination, and many workshops have been held, it is frustrating to find that there appears to be no dialogue between public health and irrigation authorities. Irrigation malaria is not a new phenomenon. As long ago as 1938 Paul Russell, quoted in this book, pointed out that irrigation *per se* was not a problem, but ‘untidy’ irrigation was. The plates in this monograph illustrate exactly what he meant. Unregulated stretches of seepage water overgrown with vegetation, and spreading, meandering water channels represent wastage of water, which is a scarce and precious resource, as well as a health hazard. Undoubtedly, canal maintenance must be difficult in sandy desert soil, but the socio-economic costs of disease and water loss might well justify the extra expense of lining at least the main canals with concrete.

Despite some shortcomings, this monograph remains a valuable source of information to the specialist reader, as well as providing general readers with a new perspective on the biological effects of environmental changes. There are lessons to be learned here. For instance, when recommending rainwater harvesting, one should take care not to proliferate new man-made breeding sites for mosquitoes.

The monograph deserved better presentation. Some errors have been picked up in 'Errata', but the pages are peppered with misspellings too numerous to list. Sometimes we have Russell, and sometimes Russel, Runn of Kutch, sepage and so on. A good editor would have corrected these and removed repetition, besides picking up the occasional table or figure rendered incomprehensible by a missing sub-heading.

And what is the insect with unconvincing clear wings doing on the cover? Every schoolboy knows that *Anopheles* has spotted wings.

■RACHEL REUBEN

2. FRESHWATER FISHES OF PENINSULAR INDIA by R.J. Ranjit Daniels, 2002. Published by Universities Press for the Indian Academy of Sciences. 288 pp (14 x 21.5 cm). Price Rs. 290/-.

The book is second in the series of publications to be brought out under Project Lifescape, an initiative of the Indian Academy of Sciences to popularise and enhance the quality of science education, and hopefully, aid India's efforts at conservation of its biological diversity.

The publication deals with 75 taxa of fishes of Peninsular India, including some introduced species from northern India and other countries. The book has 75 black and white (B/W) drawings of these taxa; the same illustrations are also depicted in colour in the plate section. The B/W drawings also cover the related taxa of some species. The book has sections or chapters on habitats of freshwater fish, fish communities, field identification of fish, illustrated keys to identification of groups of fishes, fish sampling, projects for students, aquariums, and conservation and management of fish. The publication needs to be applauded, for it deviates from the available 'run of the mill' books on Indian fish due to the inclusion of the sections or chapters discussed above. Further, one gets the impression that the book is backed by a lot of Daniels' own field (or aquarium) observations, and is not a case of the usual cut and paste job - with revisions, based on museum specimens. I recommend it as a buy for students and those who seek to know more about our freshwater fishes.

Regarding the illustrations, I find the vertical positioning (instead of the desired horizontal placing) of some of the species not to my liking due to the need to turn the book sideways to look at them. To add to the problem, some of these have the heads facing down, while it's tail-down in others! I feel that the duplication of plates in B/W and colour is unnecessary. Only the colour plates could have been used, with additions of related taxa given in the B/W drawings. Taxonomic illustrations for fish must have a scale-line. I find it strange that scales are given the go by in Indian fish guides, as is the case with Daniels' book and two major fish books by Indian taxonomists, namely Talwar and Jhingran's INLAND FISHES and Jayaram's THE FRESHWATER FISHES OF THE INDIAN REGION. However, Daniels has given the sizes of all the species in the text, following Talwar and Jhingran.

The printer's devil has taken a toll on some of the plates, too much of green in some species – it would have been great for the aquarium trade if these colours were true! The artist (the author himself) has done a satisfactory job of the paintings, but the plate of the Banded Snakehead *Channa striatus* (Plate 74) must be improved in the next edition. This species is a splendid specimen of a fish, but looks more like a poor goby in this book due to the erroneously shown protruding eyes. A lacuna in the illustrations is the omission of the name of species in contention in multi-species plates. For example, in the plates of loaches (p. 159), one needs time to realise that the second, third and fourth drawings are those of *Botia lohachata*. I also failed to find differences between aquarium and wild forms of the Dwarf Gourami *Colisa lalia* (fig. 69, p. 235) - was this intended to be a colour plate (where the differences would have been obvious)?

Besides other areas, the distribution of the Dwarf Gourami is stated as from 'Chennai through Orissa', which is not cited in earlier fish books. This 'north Indian' species has now spread in the southeastern states (and elsewhere?) due to accidental or intentional introductions of this popular aquarium fish into local waters. The exotic Mozambique Tilapia *Oreochromis mossambica* is stated to be distributed throughout India. I have not come across the species in northern India, and Talwar and Jhingran state that it cannot survive below 10 °C, which rules out its occurrence in northern India.

The Long-whiskered Catfish *Mystus gulio* is described as a 'dark' catfish, with black-edged fins. The species is common in my study area (Sriharikota), and young to mid-size specimens are a beautiful silvery with hyaline fins when seen in an aquarium. FRESHWATER FISHES OF SRI LANKA by R. Pethiyagoda (1991) also shows it as a silvery fish with hyaline fins. Discards by fishermen look dark - is this a case of dead fish showing false colours? One drawback of Indian fish taxonomists is that descriptions have been largely based on preserved specimens, except where written by taxonomists-cum-aquarists. Colours tend to change quickly after death. Even with 'landed' live specimens, much is amiss as fishes tend to show their 'true colours' only after acclimatization in an aquarium.

The following changes/additions could be incorporated in revised editions of the publication:

A map showing Peninsular India, highlighting its river systems and major water bodies is a must, with a two or three-page write-up on them.

Interesting, odd shaped species could be included to generate interest in fish, such as razorfish (*Notopterus*) and fresh or brackish water forms of puffer fish. The Freshwater Mullet *Rhinomugil corsula*, a shoaling, surface-swimmer that pops its eyes above the water can entice students to 'fish-watch'. This North Indian species has established itself in some southern rivers after accidental introduction. It has not been listed in the freshwater species checklist of India given in the book — a necessary correction. Diadromous species that need inclusion are the Ox-eye Tarpon *Megalops cyprinoides* and Indian Bass (Barramundi) *Lates calcarifer*, both of which enter and adapt well to fresh water. These two species should have precedence over shads, whose tenure in fresh water is short (in the monsoon) and generally confined to the lower reaches of estuaries.

Among Suggested Reading (written wrongly as Readings), I find that B.F. Chhapgar's COMMON FISHES OF INDIA has not been listed. This is a simple and informative publication of WWF-India, covering both fresh water and marine fish species. It is an excellent book for beginners, and one of the few Indian fish books with scale lines in the illustrations.

■ RANJIT MANAKADAN

3. FLORA OF UDUPI by K. Gopalkrishna Bhat, 2003. Published by Indian Naturalist, Udupi. vii+913 pp + 160 plates (24 x 18 cm). Hardbound, Price Rs. 1,200/- US$ 50.

This book contains descriptions of 1,247 species, belonging to 694 genera and 171 families, found in Udupi Taluka (929 sq. km), which covers one third of Udupi district. This is the second book on the area covering a single taluka, an administrative unit, the first being FLORA OF SAVANTWADI by S.M. Almeida (which records 1,685 species in *c.* 1336 sq. km).

The author Dr. K. Gopalkrishna Bhat, a Professor of Botany for the last 31 years, presently heads the Department at Poornaprajna College, Udupi (Karnataka). He received his doctorate on 'Taxonomic studies of grasses and sedges of Coorg and South Kanara districts'. He is the recipient of Prof. V.V. Sivarajan award for Angiosperm Taxonomy. Dr. Madhav Gadgil who has written the foreword for this book rates him as a taxonomist of calibre.

The book, however, is not a taxonomic floristic account in the traditional sense and format. It is a systematic account restricted to the angiosperm material found in Udupi Taluka. It can be termed as an advanced version of SYSTEMATIC BOTANY by Prof. R.N. Sutaria, which is out of print and much sought after by college teachers and students. In this regard, it will be a very useful book at undergraduate level. It cannot be an aid to research, due to the following main reasons.

1. Complete citations of the original reference to the names are not given and taxonomic validity of the names used cannot be verified.

2. No bibliography is given and one cannot ascertain whom the author is following regarding nomenclature, as many of his accepted names are out-dated.

3. There is no citation of specimens on which the identification is based.

4. Specific locations are not cited in distribution of species.

In short, the book has become a textbook of systematic botany for students of Udupi and perhaps Karnataka and its adjoining states.

I do not believe that this book has a comprehensive list of plants found in Udupi. As an example, under genus *Brassica* L., only one species *B. juncea* (L.) Zern. & Cross is listed. Surely vegetables like cabbage, cauliflower or Knol-Kohl from that genus are also cultivated in Udupi. One cannot take lightly that the common Radish (*Raphanus sativus* L.) is not cultivated in Udupi.

Rev. Fr. C. Saldanha used to say that a book which is outdated when published, is more harmful than one that remains unpublished. Despite the limited resources and literature at his disposal, Prof. Bhat should have at least ensured that the nomenclature was up-to-date. The following names used require a fresh look.

1. *Tinospora cordifolia* (Willd.) Hk. f. & Thoms.
2. *Mammea suriga* (Buch.-Ham. ex Roxb.) Kosterm. (This is an illegitimate name!).

3. *Impatiens oppositifolia* L.
4. *Sapindus laurifolius* Vahl
5. *Buchanania lanzan* Spr.
6. *Nothopegia racemosa* (Dalz.) Ramam.
7. *Moringa oleifera* Lamk.
8. *Rourea minor* (Gaertn.) Alston
9. *Memecylon malabaricum* (Clarke) Cogn.
10. *Osbeckia muralis* Naudin (1850)
11. *Woodfordia floribunda* Salisb.
12. *Anthocephalus chinensis* (Lamk.) A. Rich.
13. *Benkara malabarica* (Lamk.) Thiruv.
14. *Bridelia retusa* (L.) Spr.
15. *Bulbophyllum neilgherrense* Wt.
16. *Amischophacelus axillaris* (L.) Rao & Kamathy
17. *Canthium dicoccum* var. *umbellatum* (Wt.) Sant. & Merch.
18. *Hedyotis cynantha* Kurz.
19. *Neanotis rheedii* (Wall. ex W. & A.) Lewis
20. *Embelia tsjeriam-cottam* (R. & S.) DC.
21. *Ellertonia rheedii* Wt.
22. *Ervatamia heyneana* (Wall.) Cooke
23. *Ichnocarpus frutescens* (L.) R. Br.
24. *Parsonsia laevigata* (Moon) Alston
25. *Ipomoea campanulata* L.
26. *Ecbolium ligustrinum* (Vahl) Vollasen.

Identification of plants like *Hibiscus surattensis* L. and *Ochna obtusata* DC. should be rechecked. *H. surattensis* L. is an erect herb, originally described from the coastal areas of the Bombay Presidency. It is not a scandent climber. *Ochna obtusata* DC. is a cultivated ornamental garden plant. This name is very often confused for an endemic wild plant in southern India.

Mammea suriga (Buch.-Ham. ex Roxb.) Kosterm. is based on an illegitimate name, due to the inclusion of a synonym under its basionym by Roxburgh when he first effectively published this name. The correct name for this species is *Mammea longifolia* (Wt.) Planch.

The name *Impatiens oppositifolia* L. is based on a figure in Hortus malabaricus ("Kondam-puliu" vol. 9: 57, t. 31, 1689). This plant is now identified as *Gratiola oppositifolia* (Retz.) Mukherjee, which is based on a later synonym of the species *Gratiola oppositifolia* Retz. The correct name for the species therefore is *Impatiens rosmarinifolia* Retz.

The correct name for Kadamba-vriksha is *Neolamarkia cadamba* (Roxb.) Bosser (not Boiss). *Anthocephalus chinensis* (Lam.) A. Rich. is not synonymous with our plant. It is synonymous with *Anthocephalus indicus* A. Rich. Actually, Theodore Cooke in FLORA OF BOMBAY PRESIDENCY confused the species with 'Cadamba' and later authors accepted the name of a distinct Chinese species for our plant. It is therefore necessary to understand various problems involved in correctly naming this species.

The price Rs. 1200 is inevitable due to so many coloured pictures. In fact, most plant identifications nowadays are done with the help of coloured pictures and not as they should from the text and relevant information in the book. Dr. Bhat has handled the subject of the book with the mastery of a teacher. I recommend the book for undergraduates and new enthusiasts of plant science.

■ M. R. ALMEIDA

4. ON THE SPADE-NOSED SHARK, *SCOLIODON LATICAUDUS* by R.V. Ranade, 2001.

Published by Himalaya Publishing House, Mumbai. 125 pp + 9 plates (24 x 16 cm). Price Rs. 350/-

In today's technological age, when molecular biology and biotechnology are the latest word in zoological studies, subjects like systematics and anatomy are often considered old fashioned and *infra dig.* Animal rights activists even frown on dissection, advocating instead, computer simulation. These "bleeding hearts" may not realise that infinite patience and a steady hand, so essential for minute dissections, are the foundation stones for surgical training; a surgeon cannot operate on a patient with only computer simulation training!

Dr. Ranade's work is stolid, old fashioned slogging. On seeing it, at first I thought it would be a modern re-hash of Thillayampalam's classic (1929) memoir, but on going through the present work I realised that he has treated the shark in much more detail and elaborates on recent findings. For example, Thillayampalam had only mentioned the ampullae of Lorenzini; today these are known to have a unique electroreceptory function, sensitive to electric currents as small as 0.5 millivolts. The book is a must for any student aspiring to dissect sharks.

Scoliodon laticaudus has had its share of taxonomic confusion and subsequent revision. Known earlier as *Scoliodon sarakowah*, the shark is now the sole representative of the monotypic genus *Scoliodon*, the other species, namely *acutus*, *palassorah* and *walbeehmi* being relegated to the genera *Loxodon* and *Rhizoprionodon*.

Though the text is, on the whole, of very good quality, a few errors and omissions may be pointed out. Thus, on page 1 the author states that "aulpidiyan" is a "Malayalee" word. A Malayalee is an inhabitant of Kerala; their language is Malayalam. Again, on page 1: Bottom trawls, and not dredge nets, are used for prawn fishing off Alibag.

Of the most dangerous category of sharks, the author has mentioned three, namely tiger shark, great white shark and bull shark. Nine species of sharks are involved in attacks on humans; the others are lemon, dusky, blue, white tip, mako and hammerhead sharks.

Pages 2 and 3 (no. 9): The pelvic fins — and not anal fins — are also called ventral fins. On page 3 (no. 8) the author states the position of pectoral fin origin as being between the third and fourth or fifth gill slits. But his illustration on page 5 shows this fin completely behind the last gill slit.

Other errors are: page 17, bottom line has the word "basapophysis" twice, but in figs. 2.5 A and B it is spelt "basopophysis". Page 23, line 4 straited — should be striated. Page 32, line 10 from bottom: density 800 gm litre; the word "per" should be inserted between gm and litre. Page 47 (in Ventral Aorta), "corabranchial" should be "coracobranchial". Page 50 and fig. 6.2: "spleenic artery" should be "splenic" Page 72: "envelopes" should be "envelops". Page 75, fig. 10.2: "saccus vasculossus" should be "vasculosus" (as correctly spelt in figs. 10.3 and 10.5).

The quality of reproduction of plates (especially Plate 1) is deplorable; the use of better quality glossy paper would have helped considerably.

These are minor aberrations; also irritating are the extremely conservative use of commas, and usage of i.e. (that is) instead of viz. (namely). But these should not deter the reader from using the otherwise excellent piece of work.

The author is fortunate in that students can still legally collect and dissect *Scoliodon*, as the Government of India had placed all Elasmobranchs in Schedule 1 of the Wildlife (Protection) Act, 1972, thus effectively stopping all fishing for these fishes. However, better wisdom prevailed and only nine Elasmobranchs are now retained in this Schedule.

■ B.F. CHHAPGAR

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MISCELLANEOUS NOTES

1. RECORD OF A LEOPARD *PANTHERA PARDUS* IN PULICAT LAKE

Pulicat Lake (13° 24'-13° 47' N; 80° 03' to 80° 18' E) is the second largest (461 sq. km) brackish water lagoon in India, sprawling across the states of Andhra Pradesh and Tamil Nadu, and is bordered by villages and forested areas.

A full grown male leopard (length 152 cm; wt 52 kg) was found dead in the mudflats of Pulicat Lake in June 2001. The leopard was picked up by fishermen while fishing in the area between Sriharikota and Venadu Islands and handed over to the Forest Department.

Sriharikota has a good population of feral cattle, Wild Boar and Chital in the remnant patch of tropical dry evergreen forest of the island. The leopard could have possibly come from the nearby forest areas, however, there have been no records of leopard in Sriharikota over the past 30 years.

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2. OCCURRENCE OF SHORT-NOSED FRUIT BAT *CYNOPTERUS SPHINX* (VAHL) IN VILLAGES OF TAMIL NADU STATE, INDIA

The diversity of bat species in India is rich, about a hundred species including 12 species of fruit bats (Mistry 1995). Nevertheless, the population status, distribution, and ecology of most Indian bats are not well known (Bates *et al.* 1994, Bates and Harrison 1997). We carried out surveys between January 23 and September 30, 1998 in villages, such as Mullayampatnam, Pandanallur, Tirunagiri, Pulicat and Vedanthangal in the districts of Nagai, Thiruvallur, and Kanchipuram to determine the occurrence of the Short-nosed Fruit Bat *Cynopterus sphinx*. Mist nets were used to capture the bats and to each bat captured, a wing band was attached. Data was recorded on the location, habitat type, date, time, sex, age, and body measurements. The density of Short-nosed Fruit Bats was calculated only at Tirunagiri (Nagai District) by counting the number of bats on some trees and multiplying this by the total number of occupied trees (Mutere 1980). Nocturnal observations were made in moonlight and dim red lights (Barclay and Bell 1988) and the foraging activity data were recorded using all-occurrences sampling method (Altmann 1974).

The Short-nosed Fruit Bat occurred in all the surveyed sites in habitats such as plantation, rice field and forest (Table 1). The average number of bats caught and released per hour ranged from 1 to 4.5, indicating that they were common. In April 1998, the relative density of the Short-nosed Fruit Bat was estimated at Tirunagiri where a total of 216 palm trees were found in 1 sq. km. The average density of bats occupying 10% of the available trees was estimated to be 74 /sq. km. A total of 55 bats (24 males and 31 females) were captured at the same site between August and September 1998. Females with young were caught during March and April (n=9) and September (n=5) indicating two distinct breeding seasons. All captured bats were safely released within five minutes with no mortality.

The bats roosted mainly on the Palmyra palm *Borassus flabellifer*; each tree had 1-3 tents with 5-10 individuals in each tent. The bats modified the leaves by chewing the veins and leaf blade from below to make tents, also reported by Balasingh *et al.* (1993). The bats roosted in palm trees with dense lower leaves, which the local farmers periodically removed to extract toddy, causing occasional disturbance to their roost. No bats were seen roosting in buildings and houses.

There was no difference in the body weight, body length, tail, hindfoot, ear, forearm and wingspan measurements between the two sexes (Table 2). The data from our study is close to an earlier report by Bates and Harrison (1997).

Table 1: Average number of Short-nosed Fruit Bats captured and released per hour during mist-net surveys

Name of village/town and district	Habitat type	Average Number of bats/hour	Standard deviation
Mullayampatnam (Nagai)	Plantation	3.43	-
Pandanallur (Nagai)	Rice field	1.00	-
Tirunagiri (Nagai)	Rice field	3.16	1.29
Pulicat (Thiruvallur)	Plantation	1.98	2.39
Pulicat (Thiruvallur)	Forest	1.10	0.14
Vedanthangal (Kanchipuram)	Rice field	4.50	4.62
Total average		2.83	2.56

Table 2: Body measurements of the captured Short-nosed Fruit Bats

	Weight* (g)	Head and Body (mm)	Tail (mm)	Hind foot (mm)	Ear (mm)	Forearm (mm)	Wing span (mm)
Female (31)	51.4 ±5.1	85.3 ±12.0	16.3 ±1.9	16.6 ±1.8	19.3 ±1.5	70.5 ±1.8	463.7 ±15.3
Male (24)	51.8 ±4.2	89.5 ±12.3	15.4 ±2.3	16.4 ±1.7	19.5 ±2.0	70.0 ±2.0	467.7 ±11.3
Mean	51.6 ±4.7	87.1 ±12.2	15.9 ±2.1	16.5 ±1.8	19.3 ±1.8	70.3 ±1.9	465.4 ±13.7

Short-nosed Fruit Bats produce high pitched vocalization audible to the human ear and can be identified easily while feeding and flying around trees. They fed on 10 plant species, *Madhuca indica*, *Ficus benghalensis*, *Ficus religiosa*, *Musa paradisica*, *Polyalthia longifolia*, *Calophyllus polyanthum*, *Syzygium cumini*, *Bombax ceiba*, *Psidium guajava*, and *Gardenia jasminoides*. They fed mainly on fruit and occasionally on nectar and leaves. Banded bats were observed to carry fruit 100-2000 m away from the foraging sites to their roosts.

Fruit bats are excellent seed dispersers, pollinators and indicators of habitat diversity, but the Indian Wildlife (Protection) Act, 1972 categorises all species of fruit bats as vermin. No quantitative data exists on the extent of damage caused to cash crops in south India, either by the Short-nosed or other species of fruit bats. In Tamil Nadu and the neighbouring state of Kerala, Elephant *Elephas maximus* and Wild Boar *Sus scrofa* were mainly reported to cause damage to agricultural crops, along with Hanuman Langur *Semnopithecus entellus*, Bonnet Macaque *Macaca radiata*, Porcupine *Hystrix indica*, Gaur *Bos frontalis*, Sambar *Cervus unicolor*, Barking Deer *Muntiacus muntjak*, Mouse Deer *Moschiola meminna*, Black-naped Hare *Lepus nigricollis*, Malabar Giant Squirrel *Ratufa indica* and Indian Peafowl *Pavo cristatus* (Veeramani and Jayson 1995). Since not much is known on the extent of damage done to orchards by fruit bats, future studies should focus on this aspect.

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3. A NOTE ON DISTINGUISHING *GERBILLUS GLEADOWI* AND *GERBILLUS NANUS* BASED ON THEIR FOOTPRINTS IN THE THAR DESERT, INDIA

Tracking is one of the most effective methods for determining the preference, movement, home range and habitat use by small mammals (Sheppe 1965; Maybee 1998). It has been used successfully in wildlife and pest control (Sheppe 1965; Spaulding and Jackson 1984; Ratz 1997). Compared to live capture traps, tracking does not restrict the animal's movement, allows one to cover a larger area and is also less time and labour intensive (Sheppe 1965; van Apeldoorn *et al.* 1993; Maybee 1998). It does not involve handling of rodents, thereby reducing exposure to transmissible diseases (Drennan *et al.* 1998). Various methods like aluminium tracking plots, weather resistant tracking stations, sand, dirt and lime track beds have been used for studying small mammals (Sheppe 1965; Spaulding and Jackson 1984; van Apeldoorn *et al.* 1993).

There is no information on species level identification from tracks and signs for any of the small mammals in the Indian subcontinent. Here we describe the distinguishing characteristics of footprints of two gerbil species, *Gerbillus gleadowi* and *G. nanus* for field identification. The characters were recorded from track plots. Compared to track stations, track plots allow easy movement of animals, are less expensive and easy to lay. Footprint identification was standardised to help in the study of habitat use by gerbils in the Thar desert, India.

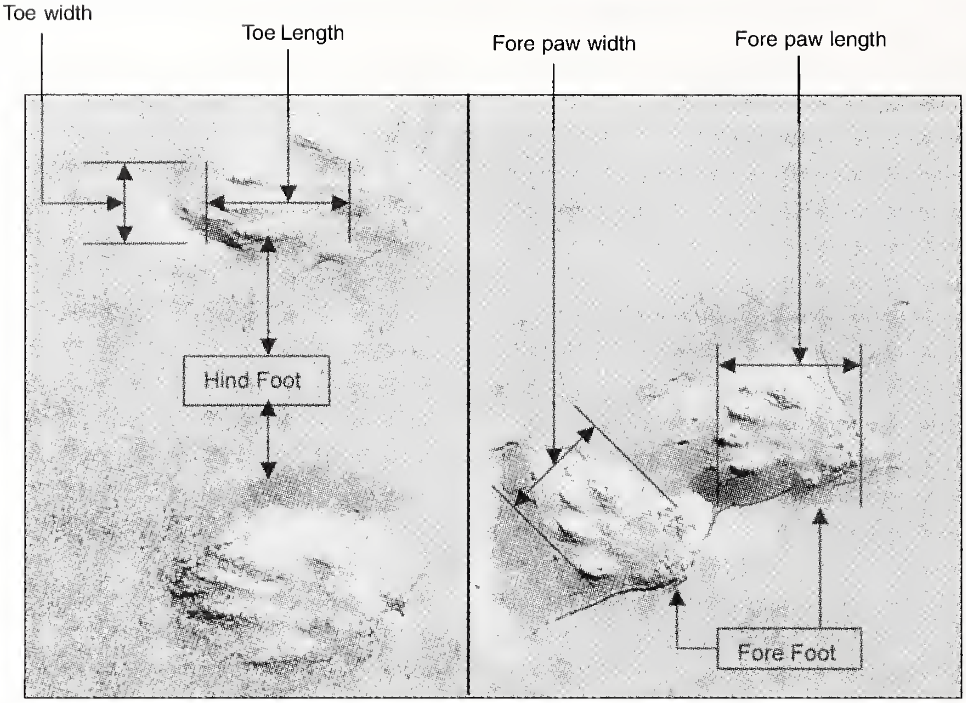

Fig. 1: Measurements of various foot print characteristics

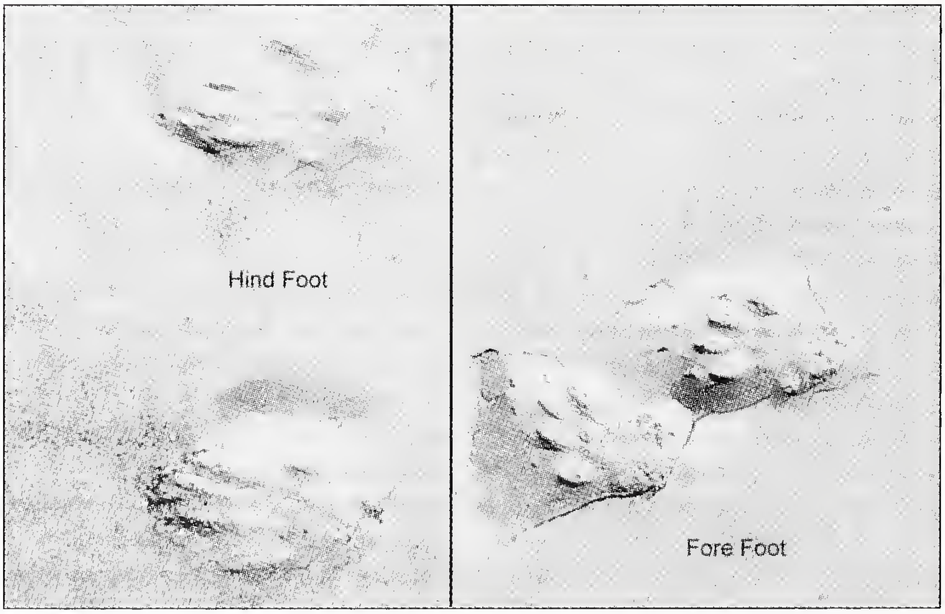

Fig. 2: Hind foot (left) and fore foot (right) tracks of *Gerbillus gleadowi*

Sand tracking is one of the most widely used techniques for studying desert rodents in the field. In this method, sand is smoothened in a small patch. The rodents leave footprints on these stations while foraging. These tracks form the basis for studying their movements.

Three species of gerbils, *Gerbillus gleadowi*, *G. nanus* and *Meriones hurrianae* have been reported from the sandy habitats of Rajasthan desert (Prakash 1996). Of these, *Gerbillus gleadowi* and *G. nanus* are nocturnal, while *Meriones hurrianae* is diurnal during winter and crepuscular during summer.

Meriones hurrianae could be studied by direct observation, but for habitat use by nocturnal species we had to study their footprints. Initially we tried to establish differences in the footprints of the two species with captive live specimens at the Central Arid Zone Research Institute,

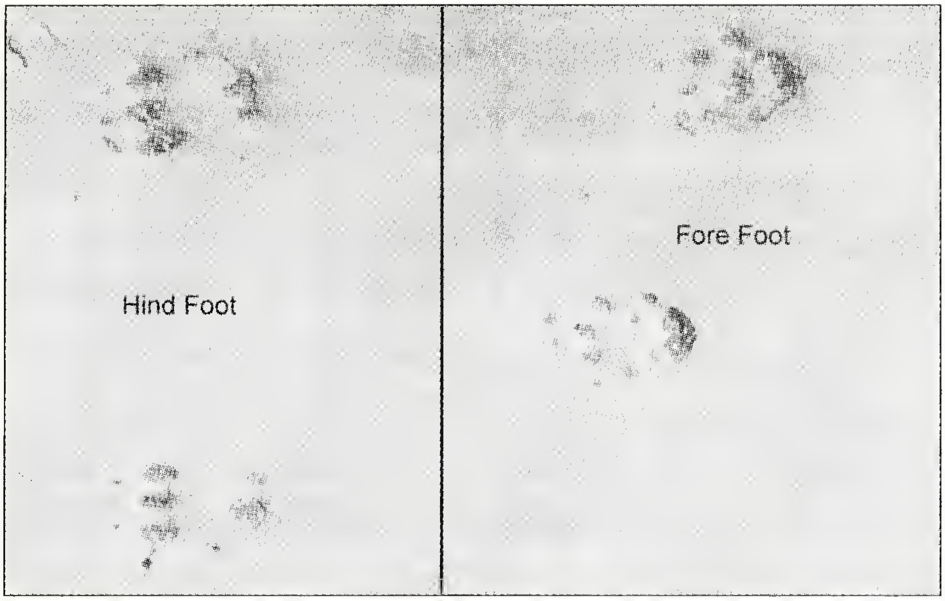

Fig. 3: Hind foot (left) and fore foot (right) tracks of *Gerbillus nanus*

Jodhpur. With sand as the substrate they did not leave good quality tracks. Hence it was not possible to distinguish between the two species. Thereafter, we experimented with lime, which gave a better resolution, allowing us to distinguish the two species from their footprints. Lime being hygroscopic absorbs moisture from the air at night. This makes the track plots less prone to damage by wind activity (in field) and also helps in obtaining a better quality print. For making track plots, lime was first sieved on to the soil and then a metal plate (used by masons) was used to smoothen it. This made the plot more compact, which in turn left a better quality track. We measured the length and width (in mm) of the forepaw and hind foot (toe – 2nd, 3rd and 4th) (Fig. 1). The track plots were laid in the evening (an hour before sunset) and checked early morning when the shadows were very vivid and tracks easiest to read.

The measurements of the fore and hind foot indicate a distinct difference in the footprints of the two species (Table 1). The most prominent is the difference in toe length (TL) (Table 1, Fig. 2). The mean TL of *Gerbillus gleadowi* was 6.32 mm, while that of *G. nanus* was 1.7 mm. The other important difference was in forepaw length (FPL). *Gerbillus gleadowi's* FPL ranged from 9.84-11.28 mm, while that of *G. nanus* ranged from 5.84-7.38 mm. These two differences formed the basis on which the tracks of the two species could be distinguished in the field (Fig. 2). The other differences were seen in forepaw width and toe width (Table 1).

Table 1: Footprint measurements [Mean (mm) ± S.D. (Range)] of *Gerbillus gleadowi* and *G. nanus* on lime track plots (n=6)

Measurement	*Gerbillus gleadowi*	*Gerbillus nanus*
Front paw length	10.39 ±0.52 (9.84-11.28)	6.94 ±0.55 (5.84-7.38)
Front paw width	6.24 ±0.46 (5.86-7.14)	4.29 ±0.54 (3.26-4.98)
Toe length	6.32 ±0.54 (5.54-7.14)	1.7 ±0.13 (1.52-1.84)
Toe width	4.34 ±0.40 (3.68-4.7)	3.43 ±0.39 (2.88-3.8)

Standardisation of tracks of the two gerbil species in the Rajasthan desert helped us study their movement and habitat use. Similar studies are required to catalogue the track differences among various species of rodents, which could be used to study prey abundance of small carnivores. Compared to Sherman traps, track plots would give better estimates of the relative abundance of small mammals, as it does not restrict the animal's movement and or involve biases, such as trap shyness or trap happiness.

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4. *RHINOCEROS RUGOSUS* – A NAME FOR THE INDIAN RHINOCEROS

The German zoologist Johann Friedrich Blumenbach introduced a new name for the Indian Rhinoceros (*Rhinoceros unicornis* Linnaeus, 1758) in the first and second editions of the *Handbuch der Naturgeschichte*, published in 1779 and 1782. He changed the names in subsequent editions. His nomenclature is viewed in a historical perspective.

Blumenbach's Handbuch

Johann Friedrich Blumenbach (1752-1840) was appointed lecturer of medicine and curator of the natural history collection at the University of Göttingen in Germany in 1776. Two years later he became full professor and remained at the same university for the rest of his career, initially as a colleague of Johann Friedrich Gmelin (1748-1804), who edited the 13th edition of the *Systema Naturae*. Blumenbach is well known for his contributions to anthropology, comparative anatomy and theoretical biology, and was a prolific author on these subjects (Kohn 1992: 56). To serve as a text for a one-semester course in natural history, he compiled *Handbuch der Naturgeschichte* (HANDBOOK OF NATURAL HISTORY), first published in 1779. This was intended as a summary of the world's fauna with short descriptions of each species, similar to the *Systema Naturae* by Carl Linnaeus (1707-1778). Blumenbach confidently and consistently followed the system of nomenclature and systematics introduced by Linnaeus. Although copies of the *Handbuch* in international zoological libraries are few, twelve editions were produced between 1779 and 1830. The fact that it was a required text for all his students probably explains this incongruity.

Two species of Rhinoceros

When Blumenbach wrote the first edition of the *Handbuch* in 1779, the systematic status of the two-horned rhinoceros was still under review. Linnaeus (1758) had been ahead of his time in listing *Rhinoceros bicornis* as a valid species, but his diagnosis appeared to be confused (Rookmaaker 1998). Blumenbach at first suggested that rhinos only differed in the number of horns, hence the African animal was no more than a variety of the Asian species: "Sie sind aber weiter in nichts von gemeinen Nashorn verschieden, und für eine blose Spielart von diesem anzusehn"(Blumenbach 1779: 135). While working on the second edition of 1782, he heard about the monograph on the African rhinoceros by Petrus Camper (1722-1789) published in Dutch in the same year, but he had not seen the book and he did not change his classification. Camper (1782) studied the anatomy of the African rhinoceros in detail and found that it differed from the one-horned animal not only in the number of horns, but more significantly in the differences in the number and form of the teeth, especially molars. Blumenbach accepted this argument and from the third edition of the *Handbuch* of 1788 onwards, he separated the African rhinoceros with a specific epithet (Table 1). There were further changes in the third edition: the text to each species became much shorter, and the names were thoroughly revised.

In the third edition of *Handbuch der Naturgeschichte* dated 1788, Blumenbach used *Rhinoceros unicornis* for the Asian one-horned rhinoceros and *Rhinoceros bicornis* for

Table 1: Species of Rhinoceros in the Handbuch der Naturgeschichte by J.F. Blumenbach

Date	Edition	Page	Asian species	African species
1779	1	134-135	*R. rugosus*	variety
1782	2	133	*R. rugosus*	variety
1788	3	135	*R. unicornis*	*R. bicornis*
1791	4	123	*R. unicornis*	*R. bicornis*
1797	5	126	*R. asiaticus*	*R. africanus*
1799	6	126	*R. asiaticus*	*R. africanus*
1802	Dutch	163-164	*R. unicornis*	*R. bicornis*
1803	7	123	*R. asiaticus*	*R. africanus*
1807	8	127-128	*R. asiaticus*	*R. africanus*
1814	9	128	*R. asiaticus*	*R. africanus*
1821	10	130	*R. asiaticus*	*R. africanus*
1825	11	107	*R. asiaticus*	*R. africanus*
1830	12	107	*R. asiaticus*	*R. africanus*

the African two-horned animal. This nomenclature was repeated in the fourth edition of 1791, but in the fifth edition of 1797, Blumenbach changed his mind and he called them *Rhinoceros asiaticus* and *Rhinoceros africanus* respectively. There is nothing particularly unusual about Blumenbach's systematic treatment of the two species. He was, however, very flexible in his nomenclature and, like most of his contemporaries, felt free from restraints. There were very few rules as yet how the names proposed by different authors should be applied. It is remarkable that Blumenbach made very few changes in the text of the sixth and later editions of the *Handbuch*. Even in 1830, he still recognized only two species, despite the discovery of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) in 1793 and the white rhinoceros (*Ceratotherium simum*) in 1817. His classification became increasingly outdated, possibly in line with the *Handbuch*'s use as a textbook for a general course of zoology.

A forgotten name

Blumenbach used a new name for the well-known Indian Rhinoceros when he wrote the first edition of the *Handbuch der Naturgeschichte* in 1779, in favour of others already in use at the time. He chose to name the animal *Rhinoceros rugosus*, which doubtlessly is a valid name. Fortunately, it clearly is a junior synonym of *Rhinoceros unicornis* Linnaeus, 1758. The amazing fact, which I can advance with confidence (Rookmaaker 1983), is that the *Rhinoceros rugosus* of Blumenbach has never been cited again, neither by himself, nor by any other author, be it as a valid name or in a list of synonyms. It was listed by Sherborn (1902) in his meticulously compiled catalogue of scientific names, but has not been picked out of there later. The name was completely overlooked or forgotten, and while there is no need to resurrect it after 223 years, it shows that bibliographic research will continue to discover new insights and forgotten facts. Sometimes this necessitates changes in established scientific names under the rules of nomenclature. True, this can easily be seen as an unnecessary nuisance. But at the same time, it could be avoided by incessant and wide-ranging reviews of the literature. Taxonomy, and science in general, recognizes the value of each person's contribution, even if one disagrees with the conclusions. It is, therefore, a reflection of our own limitations rather than good science to state that a certain scientific name is forgotten and hence unavailable, apparently favouring some authors above others for no intrinsic reason. The real problem is that the books written in the 18th and early 19th Century become increasingly difficult to access and to understand in their historical context. The history of our subject should not be overlooked.

Citation

The correct citation of Blumenbach's name for the Indian Rhinoceros: *Rhinoceros rugosus* Blumenbach, *Handbuch der Naturgeschichte*, first edition, 1779, p. 134. Type locality not stated, but obviously India. No type specimen identified.

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5. OBSERVATIONS ON CHICK MORTALITY IN DARTER *ANHINGA MELANOGASTER* IN GIR FOREST

The Darter *Anhinga melanogaster*, also known as the Snakebird, is widely distributed from Africa through southern Asia to the Indo-Chinese subregion, Philippines, New Guinea, Australia, New Zealand (Ripley 1982), tropical and subtropical zones of America, and also occurs in warm temperate zones (del Hoyo *et al.* 1992). In South Asia, it is distributed throughout the Indian Union, Bangladesh, Pakistan, Sri Lanka and Myanmar (Ali 1996). The nesting season of the Darter varies from June to August in northern India and from November to February in southern India (Ali 1996). In August 2001, we came across a breeding site of Darter near a natural pool locally known as "*Kodiar Guna*" near the Kamleshwar reservoir in Gir forest. Ten nests were constructed in a Jamun tree (*Syzygium cumini*) that was *c.* 11 m high. The nests were built among branches bifurcating from the bole (53 cm GBH). The pool also harbours three to four Muggers (*Crocodylus palustris*). The nests were the typical twig platforms of the species, with a cup-like depression in the centre (Ali 1996). Most of the nests (6) were constructed in the central part of the tree; one nest was on the extreme left side, and the remaining three to the right. Some of the centrally constructed nests were located very close (<1.5 m) to each other. The lowest nest was built 5 m above ground level and the highest was located at 9 m. It seems that the Darter prefers using twigs of tree or shrubs which are available around the breeding site for constructing the nest, as only twigs of the Jamun tree were used for building the nest.

Our observation started when the chicks were approximately 3 days old. Four to five chicks were seen in each nest, except one where incubation was still on. There were initially 39 Darter chicks in nine nests, but late hatching of eggs in some nests increased the total to 44 after two weeks. Of these, only 27 (61%) survived to reach the flight stage. Maximum mortality was observed after two weeks. One nest located at the extreme right, comprising of four chicks and a parent bird, suffered complete mortality within three weeks from hatching, probably due to an attack by a predatory bird. The carcasses of three chicks and an adult bird were found embedded in a *Lantana* bush below the breeding site.

Predation on Darter chicks was never observed directly, but a Changeable Hawk-Eagle (*Spizaetus cirrhatus*) was once seen circling low near the breeding site during the evening. Three destroyed eggs were later found below the tree. The bigger chicks, which regularly move and trample the nests, may also be responsible for the destruction of eggs. As some nests were constructed very close to each other, some chicks tried to beg for food from the parent bird of the adjoining nest. This led to aggressive behaviour from the parent bird, which vigorously jerked its 'S' shaped neck forward to stab the chicks of other birds with its pointed bill.

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6. SIGHTING OF WHITE-BELLIED HERON *ARDEA INSIGNIS* HUME IN POBITORA WILDLIFE SANCTUARY

The White-bellied Heron *Ardea insignis* is a highly endangered species and restricted to undisturbed reed beds and marshes in Eastern Nepal and the Sikkim terai, Bihar (north of the Ganga river), Bhutan *duars* to northeast Assam, East Pakistan, Arakan and North Burma (= Myanmar) (Ali and Ripley 1987). Collar *et al.* (1994) include it in birds to watch.

In Assam, it has been reported from Kaziranga National Park (Barua and Sharma 1999), Jamjing and Bordoloni of Dhemaji district (Choudhury 1990, 1994), Dibru-Saikhowa National Park (Choudhury 1994), Pobitora Wildlife Sanctuary (Choudhury 1996), Manas National Park (Goutam Narayan, *pers. comm.*).

In Pobitora Wildlife Sanctuary, located at 26° 12' N to 26° 15' N and 92° 2' E to 92° 5' E, in Morigaon district of Assam, between November 1996 and January 2001, the White-bellied Heron was sighted regularly at Pagladova and Tamulidova marshland. In January 1997, during the Asian mid-winter waterfowl census, we counted 16 White-bellied Herons at Pagladova in an area of 100 ha, 11 at the edge of the marsh and five on bushes beside the wetland. This is the biggest count of White-bellied Heron in Assam to date.

Pobitora Wildlife Sanctuary is located in the flood plains of River Brahmaputra and Kolong. The wetlands are full of water round the year in different lakes and swamps, with a large extent of riverine grassland and patchy woodland, an ideal habitat for rhino and migratory waterfowl. The wetlands of Pobitora Wildlife Sanctuary attract nearly 20,000 waterfowl during a good monsoon year. So far, 224 species of birds from 47 families have been recorded in the Sanctuary, which also has the highest concentration of Indian One-horned Rhinoceros (*Rhinoceros unicornis*). In the last census in 1999, the rhino population was recorded as 74, and is steadily increasing.

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7. BLACK STORK *CICONIA NIGRA* IN AND AROUND GIR FOREST, GUJARAT

The Black Stork *Ciconia nigra* is a winter visitor to northern India, Pakistan, Nepal, east to Myanmar (Ali 1996), and a passage migrant in Gilgit and Kashmir (Ripley 1982). It is known to winter in northeast and eastern Africa, eastern China, and Spain. Some scattered breeding populations are also recorded from Malawi and Namibia to South Africa (del Hoyo *et al.* 1992). It is a rare winter visitor in southern India, and has been recorded in Andhra Pradesh (Ali 1996), Karnataka, Periyar lake in Kerala (Daniels 1997), and once in Sri Lanka.

Earlier sightings of the Black Stork in Gir forest have been reported mainly from Madhuvanti reservoir and some odd populations in other reservoirs inside the forest, but a complete population survey of the species during their migratory period was lacking. The checklist of birds in the biodiversity conservation plan for Gir (Singh and Kamboj 1996) has no mention of Black Stork. Around 80 birds were observed on the bank of Madhuvanti reservoir, including a single photoframe showing 32 birds (Pathak B.J. In: *Vihang*, a Gujarati newsletter, 1999). During end-November 2001, large congregations (31 birds) of Black Stork were observed at Madhuvanti reservoir adjoining the Gir Protected Area (PA). A full-fledged survey was conducted in and around the Gir, to study their status, activity, movement pattern, and roosting behaviour. A total of 65 birds were seen in and around Gir PA; maximum population was seen near reservoirs (Fig. 1).

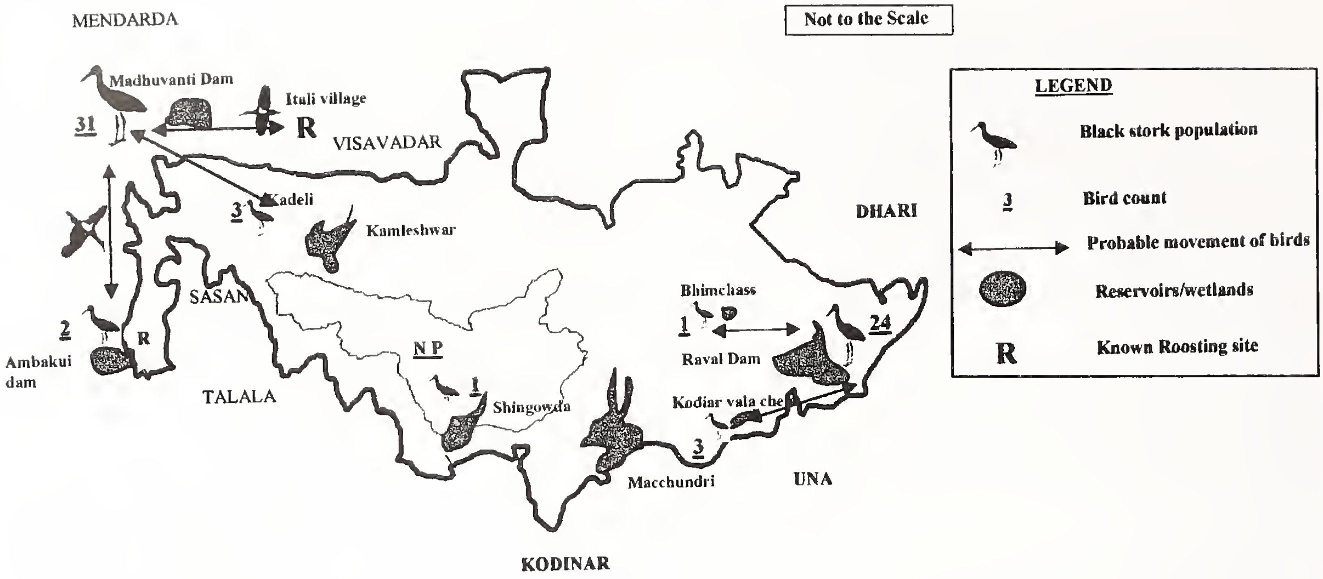

Fig. 1: Black Stork sightings in and around the Gir Protected Area during winter (2001-2002)

Counting in the various reservoirs of the Gir PA was done on the same day to rule out any error due to the movement of birds. Some isolated birds were counted in water pools and causeways inside the forest. The largest flock of Black Stork seen was of 31 birds, though Ali (1996) reported that Black Storks are found in pairs or in small flocks.

Roosting was observed in a small cliff among farmlands, between Itali and Natalia village (6 to 7 km from reservoir, Fig. 1). The Black Storks were often seen in the company of Painted Stork (*Mycteria leucocephala*) and Black Ibis (*Pseudibis papillosa*) during roosting. Such movements of birds were not observed regularly, and most of the time the birds remained on the banks of the reservoir after sunset. One instance of two Black Storks roosting on a *Boswellia serrata* tree in the evening was observed in Beria forest area (Devalia range). The Black Storks generally did not wade deep into the water in reservoirs and were seen feeding on banks. Some birds were seen in small drying water pools feeding on frogs, fish, and insects. During foraging, association with other birds like Painted Storks, White-necked Stork (*Ciconia episcopus*), Asian Openbill-Stork (*Anastomas oscitans*) and Eurasian spoonbill (*Platalea leucorodia*) were fairly common.

Remarks

Although the Black Stork is not globally threatened, its population is reportedly declining all over the world and some experts have suggested that the Black Stork should be added to the growing list of globally threatened species (del Hoyo *et al.* 1992). The Black Stork population, along with other stork species in the world, is affected by habitat loss due to excessive fishing and agriculture practices, use of pesticides, disturbance or destruction of colonies and persecution by man. This is further aggravated by the fact that very little is known about its numbers and ecology. In India, the population of this bird was estimated to be 121 during the 1991 winter census (Hoyo *et al.* 1996), while the present survey in Gir forest alone recorded 65 birds, suggesting that it may be found in higher numbers than previously thought for India during the migratory winter season. As a matter of interest, around 22 birds were observed flying over the Sarkhej area in Ahmedabad district, probably migrating to their original habitat (Pathak, B.J. *pers. comm.*, 2002).

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8. SIGHTING OF THE GREATER ADJUTANT-STORK *LEPTOPTILOS DUBIUS* IN VIKRAMSHILA GANGETIC DOLPHIN SANCTUARY, BIHAR, INDIA

The Vikramshila Biodiversity Research and Education Centre Team has been working for the last three years on the conservation of Gangetic River Dolphins in the Vikramshila Gangetic Dolphin Sanctuary (*c.* 60 km segment of the River Ganga between the towns of Sultanganj 25° 18' N and 86° 46' E, and Kahalgaon 25° 15' N and 87° 13' E) in Bhagalpur district, Bihar, India. During their regular dolphin census surveys throughout the year, the team attempted to document other biota, particularly the avifauna of the Sanctuary.

On May 23, 2001, 27 km upstream of Bhagalpur (25° 17' N and 86° 49' E) we spotted some large storks from the boat. As we landed on the bank, some members approached the storks that they identified as Greater Adjutant-Storks *Leptoptilos dubius.* The long-legged birds were walking in an area (*c.* 400 m northward from the riverbank) similar to a marshy habitat with little open water, having grasses and sedges sparsely distributed. On closer inspection, the birds were found to have a naked head and neck with a huge beak, and appeared dull in colour. The birds were convincingly identified by their gular pouches, both short and long, hanging from the neck in the adults (Ali and Ripley 1981). Immature birds were identified by the inner secondaries that appeared dirty brown. Out of the 25 Greater Adjutant-Storks, 14 were adults and 11 immature. It may be mentioned that some of our members are trained birdwatchers and have been recording the avian diversity of the River Ganga for the last seven years.

This was perhaps the first sighting of the Greater Adjutant-Stork in this region although we have regularly recorded the Lesser Adjutant-Stork (*Leptoptilos javanicus*), Asian Openbill-Stork (*Anastomus oscitans*), Black-necked Stork (*Ephippiorhynchus asiaticus*), White-necked Stork (*Ciconia episcopus*), Painted Stork (*Mycteria leucocephala*), Black Stork (*Ciconia nigra*) and Common Crane (*Grus grus*) earlier in the Sanctuary. On May 24, 2001 while on a downstream survey, we spotted the same Greater Adjutants at the same place, but this time there were 24 birds. Our fisherman also sighted the flock around the same place after a week.

Greater Adjutant-Storks are migratory wetland birds with resident populations of special conservation interest and are restricted to the Asia-Pacific region. They are Endangered species according to IUCN and face a high risk of extinction (Collar *et al.* 1994). The only recent breeding records of Greater Adjutant-Stork are from northeast India (floodplain of the Brahmaputra River in Assam) and Cambodia (Tonle Sap). Recent records of small numbers in Nepal, Thailand, Vietnam and southern Laos perhaps involve birds from the two known populations. Some 455 birds have been counted in India (Collar *et al.* 1994) and fewer than 100 at Tonle Sap (Hean *et al.* 1996). The global population estimate (restricted to Asia-Pacific region) is less than 700 birds (Perennou *et al.* 1994; Anonymous 1996). In view of their current population of 455 in India and less than 700 in the Asia-Pacific region, the sighting of 25 Greater Adjutant-Storks in Vikramshila Sanctuary appears to be very important. The number sighted in the Sanctuary fulfils the Ramsar criteria of 1% (Global population estimate of Greater Adjutant-Stork <700 and declining; Ramsar criteria of 1% = 7 Adjutant Storks).

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9. SIGHTING OF EASTERN IMPERIAL EAGLE *AQUILA HELIACA* FROM MUMBAI, MAHARASHTRA

The Eastern Imperial Eagle (*Aquila heliaca*) was reported from Maharashtra for the first time in 1983 (Goenka *et al.* 1985). This is the second record of the species from the State and first record from Mumbai. On both the occasions an adult was recorded.

I observed an Eastern Imperial Eagle soaring over mangroves and open fields at Mahul village in Mumbai on December 13, 2001 at 1530 hrs. It was a dark blackish-brown bird with a pale crown and nape patch and white scapular patches. It could not be confused with the Golden Eagle *Aquila chrysaetos* as its wings were held parallel to the body and not dihedral while soaring. The other soaring birds present were Black Kite *Milvus migrans*, Greater Spotted Eagle *Aquila clanga* and Western Marsh-Harrier *Circus aeruginosus*. The Black Kites were seen mobbing the Eastern Imperial Eagle vigorously.

The Eastern Imperial Eagle is a globally threatened bird and categorized as Vulnerable (BirdLife International 2000). It is described as a rare resident (?), but mainly winter visitor to the Indian subcontinent by Ali and Ripley (1983). Its distribution includes W. Pakistan (Baluchistan, Sind, North West Frontier Province), Nepal, north and northwest India (Kashmir, Himachal Pradesh) south to Gujarat (Kutch, Saurashtra). It has also been sighted in Rajasthan (Bharatpur and Kota) (Prakash 1988, Vyas 1993). This record indicates that its wintering range is extending towards Central India.

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10. STATUS OF WHITE-BELLIED SEA-EAGLE *HALIAEETUS LEUCOGASTER* IN SINDHUDURG DISTRICT, MAHARASHTRA

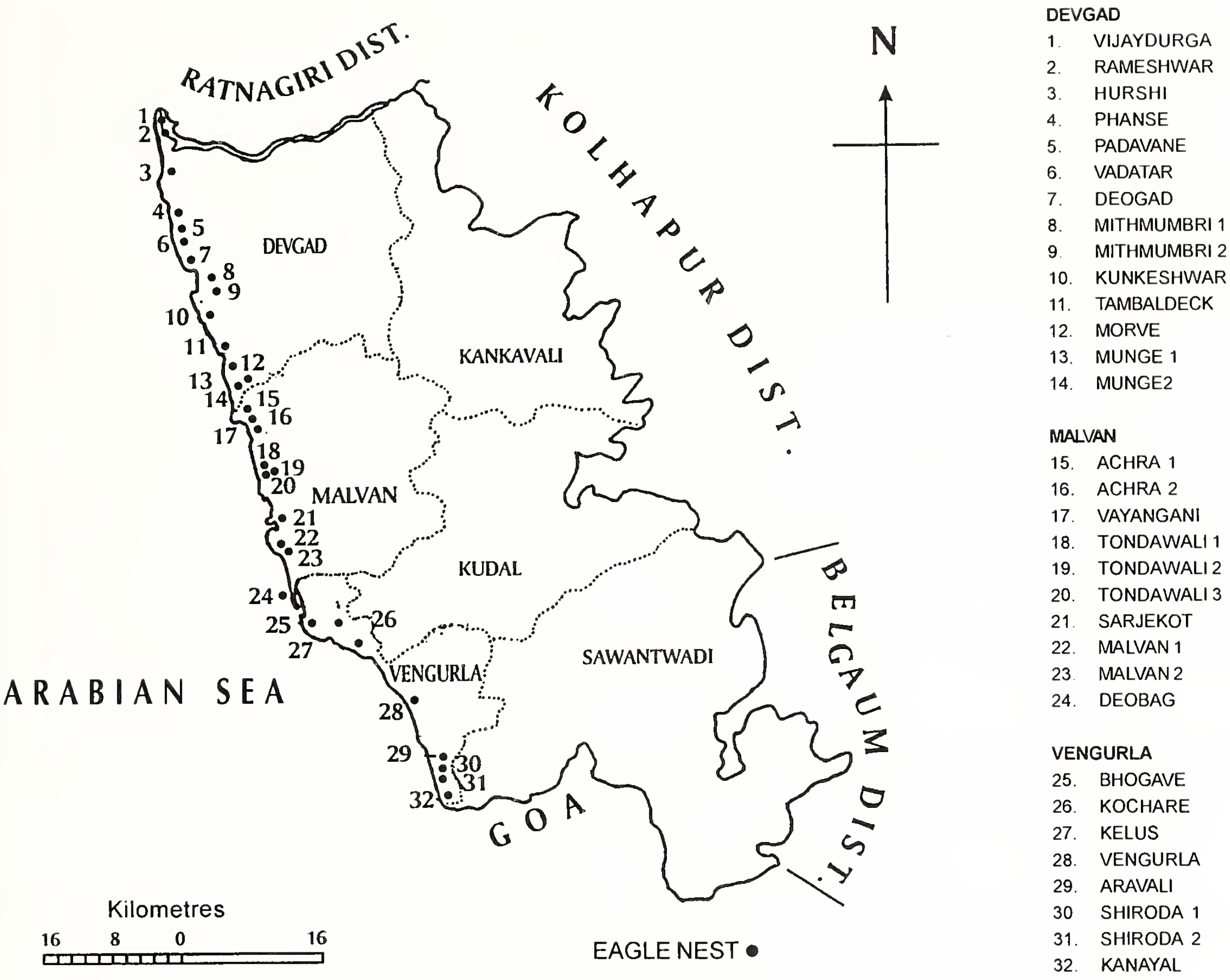
The White-bellied Sea-eagle *Haliaeetus leucogaster* is thinly, but widely distributed, and is listed as vulnerable in the Indian RED DATA BOOK. It is known to affect sea coast, tidal creeks and estuaries. The species is resident along the seaboard and offshore islands from *c.* 19° N of Mumbai down the west coast and up the east coast to Bangladesh, Laccadive Is. (now Lakshadweep), Andaman and Nicobar Islands and Sri Lanka. It is vagrant in Gujarat, and on the coasts of Burma (now Myanmar), Malay Peninsula and Archipelago east to Australia, Tasmania and W. Polynesia (Ali and Ripley 1981).

Gole (1997) reported 11 nests of the White-bellied Sea-eagle from the coast of Sindhudurg district, which is situated in the Konkan region of Maharashtra state (15° 35' N to 16° 33' N, 73° 18' E to 74° 13' E). This region experiences a hot and humid coastal climate with plentiful rain during monsoon, i.e. June to September (average 3,000 mm). The temperatures range from 22 °C to 35 °C. The mean relative humidity is 80%.

During a status survey of the coasts in Sindhudurg district in 1999, we surveyed an area up to 5 km wide along the 121 km coastline. We located 32 nests of the White-bellied Sea-eagle; 62 nests were counted in Ratnagiri district in an earlier survey (Katdare and Mone 2003). Nesting sites of the White-bellied Sea-eagle were located while walking along the coast in the breeding season (October to January) and collecting information from the locals by showing them pictures of the bird.

Tree species

White-bellied sea-eagle nests were found on seven tree species (Table 1).


RATNAGIRI DIST.
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EAGLE NEST ●
DEVGAD
1. VIJAYDURGA
2. RAMESHWAR
3. HURSHI
4. PHANSE
5. PADAVANE
6. VADATAR
7. DEOGAD
8. MITHMUMBRI 1
9. MITHMUMBRI 2
10. KUNKESHWAR
11. TAMBALDECK
12. MORVE
13. MUNGE 1
14. MUNGE2
MALVAN
15. ACHRA 1
16. ACHRA 2
17. VAYANGANI
18. TONDAWALI 1
19. TONDAWALI 2
20. TONDAWALI 3
21. SARJEKOT
22. MALVAN 1
23. MALVAN 2
24. DEOBAG
VENGURLA
25. BHOGAVE
26. KOCHARE
27. KELUS
28. VENGURLA
29. ARAVALI
30 SHIRODA 1
31. SHIRODA 2
32. KANAYAL

Fig. 1: Map of Sindhudurg district Maharashtra with nesting sites

Out of 32 nests in Sindhudurg district, only 2 nests were located on *Mangifera indica*, whereas 20 out of the 62 nests in Ratnagiri district were located on *Mangifera indica*. In Sindhudurg district, the *Casuarina equisetifolia* plantation had the maximum number of nests (20 nests, 62.5%).

Nest height

Most nests were found at a height between 10-30 m (n = 28), while 3 nests were found below 10 m. One nest was located between 30 to 40 m. 28 nests were located up to 0.4 km from the coast, while 4 nests were found 1 to 6 km from the sea, but near the estuaries. We located 32 nesting sites, saw 45 adult birds on 27 nests and two chicks on two nests. Seven adult birds were seen away from their nest. No bird was seen on one nest, but fresh droppings and remains of meals (bones, snake skins) were seen under the nest. A small amount of fresh droppings were seen under four nests. Thus, 4 inactive nests and 28 active nests (with adult birds sighted on the nest, nestlings or plentiful droppings below) were located during this survey. The average active nest density in Sindhudurg is one nest per 4.32 km. Ratnagiri district had 45 active nests (1997-1998) in 161 km, average one nest per 3.57 km.

Table 1: Tree species used for nesting by *Haliaeetus leucogaster*

Tree species	Deogad	Malvan	Vengurla	%	Total
Mangifera indica	2	0	0	6.25	2
Casuarina equisetifolia	8	7	5	62.50	20
Ficus benghalensis	1	0	0	3.13	1
Cocos nucifera	2	0	1	9.37	3
Sterculia foetida	1	2	1	12.50	4
Alstonia scholaris	0	0	1	3.13	1
Bombax malabaricum	0	1	0	3.13	1
Total	14	10	8		32

Local people

Out of 32 nests, 30 were within 500 m from houses. The fishermen have no problems with the White-bellied Sea-eagle, locally know as *Kakan*, as its call indicates the availability of fish in the sea or a change in wind direction. There is no report of hunting of this bird in the study area. Out of 32 nests, 23 are on private property, and nine on government property. Nine trees bearing nests are protected as they are government-owned and therefore safe.

Sacred trees

The villagers consider some trees, such as *Mangifera indica* and *Bombax malabaricum*, sacred. Therefore, the nests on *Mangifera indica* at Hurshi, Taluka Deogad and *Bombax malabaricum* at Sarjecoat, Taluka Malvan were unharmed.

Plantations

Large areas in Sindhudurg district are under plantations of Alfonso mango *Mangifera indica* and cashew *Anacardium occidentale*. Spraying of pesticides, removal of vegetation within the plantation, harvesting and related activities endanger the eagles. Four nests were on Coconut *Cocos nucifera*. Fearing attack by the nesting eagle, the owner first destroys the nest, then collects the coconuts.

Territory

Regarding the White-bellied Sea-eagle's territory, Ali and Ripley (1981) state "usually a single pair with vast territory, but not uncommonly several pairs and nests on the same small island."

In Sindhudurg district, we generally found nests with vast territory, but at Tondoli, Taluka Malvan, there were three nests in one village.

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11. DOES THE WHITE-BELLIED SEA-EAGLE *HALIAEETUS LEUCOGASTER* FEED ON CATTLE DUNG?

The White-bellied Sea-Eagle *Haliaeetus leucogaster* predominantly feeds on sea snakes and fishes. It also eats crabs, rats and dead fish, and is reported to prey on domestic chickens, ducks and piglets (Ali and Ripley 1987). However, an unusual observation of the bird eating cattle dung was recorded in Pulicat Lake, Nellore district, Andhra Pradesh. On October 8, 2001 at 1100 hrs, a White-bellied Sea-Eagle was seen sitting on cattle dung and feeding on it. To confirm the material being eaten, we walked into the lake towards the eagle. The eagle flew away carrying a piece of the dung in its talons. The remains of the dung left by the eagle did not have any living organisms (crabs, etc.) hiding in it. Could the bird be actually feeding on the dung itself? Feeding on lion droppings is reported in the Egyptian Vulture *Neophron percnopterus* (Houston 1988).

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12. UNUSUALLY HIGH MORTALITY OF CRANES IN AREAS ADJOINING KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

On November 23, 2000, fifteen cranes – twelve Sarus Cranes *Grus antigone* and three Common Cranes *Grus grus* – were found dead in the agricultural fields of Ajan dam, a temporary water reservoir about 500 m southwest of the Keoladeo National Park, Bharatpur, Rajasthan. The Sarus Crane is a resident, and the Common Crane is a winter migrant to the Park and its adjoining areas from October to March.

The temporary reservoir is the only source of water to the Park. Water retained in the dam during monsoon is used for agricultural practices during the year. There is regular movement of the cranes between the Ajan dam and the Park for food and roosting (Ramachandran and Vijayan 1994).

The reason of death of the cranes could not be ascertained, but circumstantial evidence suggested that they had died due to consumption of pesticide-treated seeds. The buccal cavity, esophagus and gizzard were stuffed with wheat seeds. The farmer confirmed that he had sown the seeds the previous night after treating them with pesticide. He showed the empty container which had Chloropyrifos 25% EC printed on it. The farmer had treated the seeds as it was a drought year, and water scarcity would result in heavy termite infestation. Another reason for treating the seeds with pesticide was to keep birds off the field. The farmer thought that the strong smell of pesticide from the treated grains would prevent the birds from eating them.

Chloropyrifos is a toxic and potent organophosphate. A large number of pesticide preparations are used around Keoladeo National Park, and organophosphates are most commonly used (Prakash and Rana 2001). The organophosphates do not remain in the ecosystem as they disintegrate quickly, but are highly toxic (Newton 1979) and are known to cause mass mortality of birds in areas of usage (Morzer-Bruyne 1963). In parts of Africa, high mortality of birds was recorded during Quelia control operations in which parathion was sprayed from an aircraft (Newton 1979). Lethal levels of pesticides were detected in the tissues of Sarus Crane and Ring Dove (= Eurasian Collared-Dove) *Streptopelia decaocto* in Keoladeo (Vijayan 1991). Detectable quantities of pesticides have been found in the tissues of Sarus Crane, White-backed Vulture *Gyps bengalensis*, Egyptian Vulture *Neophron percnopterus* and fish (A.M. Bhagwat *pers. comm.* 2001, Prakash and Rana 2001).

Cranes are large, long-lived, slow breeding birds and are prominent indicators of the health of the wetland (Ali and Ripley 1989, Jonhsgard 1983, Meine and Archibald 1996). Nearly 20% of the total population of Sarus Cranes in and around the Park was lost in a day, which is a cause of serious concern.

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13. BROAD-BILLED SANDPIPER *LIMICOLA FALCINELLUS*: AN ADDITION TO THE AVIFAUNA OF RAJASTHAN

On September 7, 2001 while driving to Longewala in the early afternoon, we found some waders on the drying Baramsar depression, Jaisalmer district, Rajasthan. We noticed some little stint *Calidris minuta*, but one bird looked quite different from the others in the group. On moving closer, we recognized the bird as a broad-billed sandpiper *Limicola falcinellus,* a species we had seen at Pt. Calimere (Tamil Nadu), Jamnagar (Gulf of Kutch) and Pulicat (Andhra Pradesh) earlier. However, because of the rarity value of the bird in Rajasthan, we were very cautious and took some record shots.

In the excellent light, the bird was clearly identifiable as a Broad-billed Sandpiper by the characteristic dunlin-like bill with a kink towards the tip, the snipe-like pattern of the upperparts, white belly and flanks and double white eyebrow. However, compared to the illustrations in Hayman *et al.* (1986), Beaman and Madge (1998) and Svensson *et al.* (1999) the juvenile was interesting in having only a hint of streaks on the breast. The ear coverts, neck side, chin and throat were as white as its belly and flanks. The 'lower' supercilium looked exceptionally broad and eye stripe was very faint.

Broad-billed Sandpiper is a "winter visitor to the seaboard of both Pakistan, India, Ceylon Andaman and Nicobar Islands" and "recorded less commonly in Bihar, Delhi and elsewhere - presumably on passage" (Ali and Ripley 1980). Kazmierczak and van Perlo (2000) recorded only eight inland records from the Indian subcontinent till 1999. To the best of our knowledge, the species has not been recorded in Rajasthan, except for the six recent records, including a total of twelve birds from five localities:

1999 March 7, two adults, Kochia ki Dhani, Sambhar Lake.

2001 September 1, two adults, between Sam and Jaisalmer on a roadside depression.

2001 September 19, two adults and one juvenile, Phulera Lake, Jaipur district.

2001 September 19, one juvenile, Kochia ki Dhani, Sambhar Lake.

2001 November 18, three individuals at Surwal Lake, Sawai Madhopur.

2001 November 19 one individual at Choru Lake, Sawai Madhopur.

The above records indicate a clear pattern of autumn and spring migration through Rajasthan. Perhaps difficulty in identification and paucity of observers at the crucial time are the reasons for their being overlooked in inland localities.

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14. NESTING OF TERNS ON VENGURLA ROCKS, DISTRICT SINDHUDURG, MAHARASHTRA

On June 6, 2001, we visited Vengurla Rocks (16° 35'-16° 45' N and 73° 27'-73° 30' E), Taluka Vengurla, District Sindhudurg, Maharashtra to follow up the conservation action on the Indian Edible-Swiftlet *Collocalia unicolor*.

This was the first visit to the Rocks in monsoon, the breeding season of the terns. All previous visits were made during the non-breeding season (Abdulali 1940, 1942, 1983). Madsen (1988) had observed *Sterna bergii*, *S. fuscata*, *S. repressa* and *S. anaethetus* on the Rocks from a boat.

We sailed at 0930 hrs from Nivti harbour for the island. At 50 m from the island, we saw several terns flying above the land. We landed at Bandra Rock at 1030 hrs. Dry grass was spread all over the rock. Tern eggs were present all over the Rock. There were four tern species on Bandra Rock.

Eight hundred bridled terns *Sterna anaethetus* were seen on the Rock. Their eggs were laid all over the island, under tussocks of grass and small rocks, and on bare rock.

Most of the nests contained one egg, while two nests contained two eggs each. The eggs were creamy, stone coloured with deep brown blotches. The minimum distance between two nests was 0.43 m. A male and female were seen in courtship display. They caught each other by the bill and the male walked twice in a semi-circle in front of the female.

Three hundred Large Crested Terns *Sterna bergii* were seen on the southern side on bare rock. Seventeen eggs were seen on bare rock and two on open ground in shallow scrapes. The creamy white eggs, blotched with deep brown and brownish scrawls at the broad end, and bigger than that of *Sterna anaethetus*, were being incubated.

Five Lesser Crested Terns *Sterna bengalensis* were seen in a flock of Large Crested Terns. One pair of Roseate Terns *Sterna dougallii* were seen on the rock in courtship display. At 1900 hrs, 150 Roseate Terns in scattered flocks arrived from the old lighthouse and gathered on the western side of the rock for rest. The small, noisy flocks kept flying and landing for 30 minutes.

A Ruddy Turnstone *Arenaria interpres* was also seen feeding amongst a group of Large Crested Terns. In the evening, 400 Blue Rock Pigeons *Columba livia* landed in small flocks. One White-bellied Sea-eagle *Haliaeetus leucogaster* was also seen sailing over the island.

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15. COMMON HOOPOE (*UPUPA EPOPS*) FEEDING ON PRINIA (*PRINIA* SP.) CORPSE

On October 22, 2001, while traveling from Shahada to Ranipur, Nandurbar district, Maharashtra, at about 1400 hrs, I observed a Common Hoopoe (*Upupa epops*) on the metalled road. As we passed by, I noticed that it was feeding on a Prinia (*Prinia* sp.) that was probably hit by a vehicle. Its belly was open and the intestines were hanging out; one eye too was hanging out of the socket.

As we approached, the hoopoe flew to a nearby tree. I took the Prinia with me for identification. As I returned to the vehicle, the Common Hoopoe came back and started picking up the scraps of meat on the road.

According to Ali and Ripley (1983), the Common Hoopoe is strictly an insectivorous bird. However, it has been reported feeding on lizards, frogs and toads, and exceptionally on birds' eggs (Cramp 1985), but I could not find any reference to a Common Hoopoe feeding on a bird carcass. This could be an opportunistic meal.

November 13, 2001

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16. INDIAN PITTA *PITTA BRACHYURA* IN THE THAR DESERT

Balsamand Lake lies at the foot of the low hills north of Jodhpur (25° 6'-27° 1' E to 71° 9'-74° 1' N). It commands a view of a garden on the slopes still owned by the erstwhile Maharaja of Jodhpur. I was given the opportunity of studying the fauna of this ancient lake constructed in 1159 AD. A dam was constructed here in 1873 to 1895 by Maharaja Jaswant Singhji II. There are a number of large trees of *Ficus benghalensis*, *F. religiosa*, *Azadirachta indica*, *Terminalia arjuna*, *Syzygium cumini*, *Mangifera indica*, *Aegle marmelos*, *Salvadora oleoides* and *Dalbergia latifolia*.

The first thing I saw was hundreds of fruit bats *Pteropus giganteus* clinging to a group of Banyan trees on the overflow side of the lake. *P. giganteus* does not occur anywhere else in the desert. The vegetation near the lake is so dense that it gives the impression of a forest. I regularly heard a peculiar note "*weet tew*", which I traced to an Indian Pitta (*Pitta brachyura*) that was sitting on the canopy of *Terminalia arjuna*. According to Ali and Ripley (1983) and Grimmett *et al.* (1998), the distribution of Indian Pitta excludes the western parts of Rajasthan. There is no past sighting of this bird by earlier bird watchers (Whistler 1938; Bohra and Goyal 1992; Rahmani 1996,1997; Mukherjee 1995) in the desert. Besides the Indian Pitta, some birds, like the Yellow-legged Green-Pigeon (*Treron phoenicoptera*), Coppersmith barbet (*Megalaima haemacephala*) and Asian Koel (*Eudynamys scolopacea*) which were rare here, are now commonly seen on trees with large crown cover. The call of the Indian Pitta is easily heard in the garden of Balsamand.

It appears that these birds have made Balsamand their home now that the catchments of the lake have improved in recent years. The lake no longer dries up as it used to. This perennial source of water also maintains the soil water regime at a higher level by continuous seepage, which keeps the *Ficus* fruiting all year round. It is possible that superior foliage and good food supply has resulted in the influx, from the Aravallis, of some birds that inhabit dense thickets.

May 15, 2002

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17. COMMON STARLING *STURNUS VULGARIS* IN ARUNACHAL PRADESH, INDIA

On November 8, 1999 in Sarli, a mountain village (*c.* 28° 1' N, 93° 9' E) located close to the Great Himalayan Range and along the Indo-Chinese border in the Lower Subansiri district of Arunachal Pradesh, I came across a man carrying a bird he had killed. On examination of the bird, I realised that it was a Common Starling *Sturnus vulgaris* (in winter plumage), which is unknown from this region. *S. vulgaris* breeds across the Palaearctic and is an abundant winter visitor to Pakistan and northern India (Ali and Ripley 1983; Roberts 1992). An uncommon winter visitor to Nepal and further east in Bhutan, Bangladesh, northeast India and Myanmar reported vagrant (Inskipp and Inskipp 1985; Smythies 1986; Harvey 1990; Ali *et al.* 1996; Grimmett *et al.* 1996).

This is the first record of the species from the state and is possibly a vagrant. The man said that the bird had been feeding on the ground, along with two others, in a small clearing at 1,500 m just outside the village. I took the bird from him and preserved the skin.

Morphometrics (mm): Bill length - 29, wing - 125, tail - 65, tarsus - 28

Colour of bare parts: Iris - dark brown, Bill - dirty black, Legs and feet - brownish-red, claws - dark brown.

January 14, 2002

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18. SIGHT RECORD OF HORNED LARK *EREMOPHILA ALPESTRIS* NEAR DELHI

The Horned Lark *Eremophila alpestris* is a holarctic species, widespread from arctic tundras to the high mountain plateaux. Populations breeding at high latitudes undertake annual migrations to the northern temperate zones, whereas those breeding above the tree-line in lower latitude mountain ranges show altitudinal movements. One anomalous population in the northern Andes of South America is sedentary.

In India, the species is common at high altitude in Ladakh, particularly above 4,000 m (*pers. obs.*), wintering down to about 3,000 m (Grimmett, Inskipp and Inskipp (1998), BIRDS OF THE INDIAN SUBCONTINENT).

On September 30, 2001, seven members of the Delhi Bird Group were completing an early morning visit to the Yamuna River with a walk along the bank, overlooking ash pits at Khader, south of Okhla, New Delhi. It was a clear, warm sunny morning with good visibility. The pits provided habitats ranging from open shallow water, wet substrates, patches of low vegetation and sparse grass, along with drier open ground. By 0830 hrs, we were spread out along the bank, watching Indian Short-toed Larks *Calandrella raytal*, Common Crested Larks *Galerida cristata* and Eurasian Tree Pipits *Anthus trivialis*, the latter seemingly newly arrived migrants and in a loose, noisy group of about 15.

Whilst scanning the drier region close to the southern end of the pit, checking carefully through the birds as they foraged on the ground, my attention was quickly drawn to a large stocky lark, about the size of a Common Crested Lark, but with no suggestion of a crest. Its plain, apparently unmarked upperparts matched almost perfectly the pale ashy, brown grey substrate. It was feeding close to the ground, with a shuffling, crouched gait. As it raised its head, it showed striking features of a bold black mask extending from the bill, through the eyes and on to the ear coverts, a black band across the upper breast and a narrow black line extending across the front of the forecrown. These features contrasted with the whitish facial background. The rest of the crown, nape and upperparts were a pale greyish brown. The remainder of the underparts was whitish, with no streaks.

I was immediately able to identify the bird as a Horned Lark, a species I have seen on numerous occasions over the last 25 years. I watched it with binoculars for about a minute at a range of *c.* 40 m. It then flew, showing white outer tail feathers in flight, before settling again about 50 m away in an area of sparse, short vegetation, but close to Bill Harvey and Manoj Gupta who were further along the bank. I was able to draw their attention to the lark and they also obtained a good view. In addition to the features I had noted, they pointed out the "horns", the fine black feathers that form posterior tips of the forehead marking, above the ear coverts, the almost pinkish grey of upperparts that merged so closely with the ash substrate and its streamlined, almost bunting-like shape.

Other members of the party joined us a couple of minutes later and got briefer views before the bird flew again, settling this time on a pipe on top of the bank a good 100 m away. It remained perched there for another minute before being disturbed by a passerby. Despite a thorough search for it afterwards, it was never found again. The site was checked on a number of occasions by other observers over the following week, without success.

The well-marked facial pattern and apparent absence of prominent streaks on the upperparts indicate that this individual was an adult male.

This would appear to be the first record in India south of the high Himalaya. Himalayan populations are not known to undertake long-distance migration, and winter no further south than the foothills, and even then mainly at relatively high altitude. This is a highly unexpected record of a very distinctive species, but at a time of the year when there is considerable movement of birds southward on passage. It is not inconceivable that this vagrant may have associated with small flocks of other diurnal migrants descending to wintering grounds in peninsular India.

March 26, 2002

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19. NIDIFICATION OF THE COMMON RAVEN *CORVUS CORAX* IN THE THAR DESERT

On the afternoon of February 17, 2001 we were driving on National Highway No. 12 towards Bikaner. Near Dungargarh, Bikaner district, our attention was drawn to a Common Raven *Corvus corax* flying towards a nest on an electric pylon. We scoped the nest and observed two fledged young, which were later fed by another adult which had alighted on the nest. Having confirmed the breeding of the Common Raven, we decided to examine all the nests on the electric pylons along the highway on our return journey on February 26, 2001. Between Bikaner and Dungargarh, we counted eleven nests on electric pylons. There were probably more live nests (as close sitting young were not visible from the ground), but we discounted those nests in which we did not see young birds.

We found three more nests in Jaisalmer district on electric pylons. One live nest was seen near Myajlar village on February 22, 2001. Two more nests were found between Ghotaru fortress and Bachiyan Chhor outpost in the Shahgarh bulge, in the extreme west of Jaisalmer district, on February 23, 2001. One of these nests near Bachiyan Chhor outpost contained two young. On seeing us, the adult started calling *pruk pruk pruk*, but did not venture near the nest. The young were quite unconcerned and we were able to photograph them in the nest, which was, as usual, 10 m high from the ground. It appeared refurbished and was mostly made up of entwined twigs of *Calligonum polyonoides*, at least on the outside. Five or six sticks, varying in length from 30 to 90 cm, and one thin steel strip about 100 cm x 2 cm were found on the ground directly under the nest. The diameter of the nest was about 95 cm.

According to Ali and Ripley (1986), this species nests on stunted trees hardly more than 3-4 m in the semi-desert. It "nests in the top of a solitary tree or on an earth cliff" according to Grimmett *et al.* (1998). However, all the fourteen nests we saw in Bikaner and Jaisalmer districts in the Thar desert (Rajasthan), were about 10 m high on electric pylons.

The raven is known to nest on man-made structures (Cramp and Perrins 1994). Ratcliffe (1997) lists 20 cases of nesting on radio transmitter masts and electric pylons scattered through U.K. (mostly in Wales). In southeast Iceland, 48% ravens use buildings and pylons (Skarphedinsson *et al.* 1990). Stiehl (1985) found 23% of 87 nests in Oregon on "buildings or wind pumps". Eighty-one pairs nesting on electrical transmission line towers were studied in Idaho (Steenhof *et al.* 1993).

In the Indian subcontinent, man-made structures have been used earlier by the species "A nest with 2 fresh eggs was seen on December 19 on a signal platform of the railway at Tilwara" (Whistler 1938). "In the Jhelum district, Whistler refers to their predilection for building on the iron girders under road and railway bridges" (Roberts 1992). In 1984, one occupied nest built on an electric pylon was found by T.J. Roberts near Kila Saifullah, Zhob district, Baluchistan.

In the Shahgarh bulge, Jaisalmer district, the nesting on electric pylons seems to be a recent development, as the electric pylons were not there even as late 1994 when HSS visited Ghotaru fortress. Interestingly, in the last century, Blanford found it late breeding at Ghotaru on "kandi or babur trees" (Eates 1939). The Shahgarh bulge is one of the most remote and undisturbed areas in the Indian subcontinent and many suitable trees for nesting are available. Evidently, the Common Raven finds electric pylons the safest site to build the nest. In Bikaner, however, it obviously prefers the electric pylons because the available trees of Khejri *Prosopis cineraria* are regularly lopped by farmers and are thus unsuitable.

HSS visited Jaisalmer again in June 2001 and saw juveniles at three sites. Two juveniles were seen drinking water in the afternoon at the waterhole on June 12, 2001 at Sudasri in the Desert National Park (DNP), Jaisalmer district. Earlier, on May 5, 2001 Asad Rahmani saw two juveniles following the parents at the same site. At Tanot, two juveniles were seen with an adult pair, and on the outskirts of Ranau village (between Tanot and Ramgarh) two juveniles and one adult were observed feeding on a sheep carcass on June 13, 2001. The juveniles had very conspicuous, blood-red mouths unlike the bluish-black of the adults. Compared to the adults, the juveniles looked a trifle smaller in size and lacked the bronze-brown cast on the hind neck and sides of head and neck of adult birds.

HSS has been visiting the Thar desert very regularly since 1986, but has never noticed ravens nesting before. Nor are we aware of any recent records of its nesting in the Thar desert except for the two recent records. Ashok Sharma, a member of the BNHS found one occupied nest about 12 m high on a peepal tree *Ficus religiosa* growing in a temple compound at Deepalsar, Churu district on February 8, 1996 (*pers. comm.*). On March 30, 1998, Shantanu Kumar, a noted wildlife expert with long experience found a nest on the observation tower of the Border Security Force (BSF) at Bhuttewala, Jaisalmer district. It was located on the upper watch platform (about 11 m) of the tower. Evidently, the birds were quite used to the presence of the sentry on the lower watch platform (about 6 m), but when he climbed the tower with some other people, the birds were alarmed and "came calling all the way from across the border" from the Pakistani tower! They were disturbed by the unusual presence of a large number of people and circled over the tower calling loudly.

ACKNOWLEDGEMENTS

We thank Steve Madge for reference material and Shantanu Kumar, Asad R. Rahmani, and Ashok Sharma for information. Special thanks are due to Shantanu Kumar, the Director General of Police (Rajasthan) who made the logistical arrangements during our visit to the Shahgarh bulge.

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20. UNUSUAL NUMBERS OF BLACK-HEADED CUCKOO-SHRIKE *CORACINA MELANOPTERA* AT POINT CALIMERE, TAMIL NADU

An unusual congregation of *c.* 25 Black-headed Cuckoo-Shrike *Coracina melanoptera* was witnessed during a bird watching session on December 21, 2001 at Pt. Calimere. This was our first day of the ten-day BNHS Bird-banding Training Programme and we were being guided by Dr. S. Balachandran, Scientist, BNHS. At 1745 hrs, after an eventful evening with birds, we approached the fringes of the Kodikadu village and passed through some open area with a few *Thespesia populnea* trees where we saw three Black-headed Cuckoo-Shrikes in flight, and two in a nearby *Thespesia* tree. Suddenly, several more cuckoo-shrikes began to leave the tree, and as we approached they moved to a *Prosopis juliflora* shrub on the other side of the road. We noticed a flight of more than 15 cuckoo-shrikes in a follow-the-leader fashion. They were restless, and flying between the *Thespesia* and *Moringa* trees in a backyard. Of the twenty-five birds, about six were males and the rest females.

This sighting is significant, as the Black-headed Cuckoo-Shrike is not known to congregate in large numbers. Ali and Ripley (COMPACT HANDBOOK, 1987) do not record such behaviour for the species. The group appeared like a pre- or post-migration flock, but there is no evidence to this account except their restless behaviour. These birds are not known to congregate even during the breeding period. According to Dr. Balachandran, the Black-headed Cuckoo-Shrike is a common local migrant to Pt. Calimere, arriving in winter from the nearby areas, but the numbers seen on this particular occasion were unprecedented. The coastal area at the time of observation was under the effect of a cyclonic depression in the Bay of Bengal.

March 19, 2002

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21. ON THE BEHAVIOUR AND HABITAT PREFERENCE OF STOLICZKA'S BUSHCHAT *SAXICOLA MACRORHYNCHA* (STOLICZKA)

Ali and Ripley (1973) described the endemic species Stoliczka's Bushchat or Whinchat as 'rare and very local'. Presently it is not seen in its former haunts, though it is not uncommon in the Desert National Park, Rajasthan. This species was first discovered in Kutch in the 19th Century by Dr. Ferdinand Stoliczka, who collected two specimens, one near Bhuj and the other from Rapar. He described the species and published it in the *Journal of the Asiatic Society of Bengal* in 1872. Since then, it was not sighted by the earlier chroniclers of the Birds of Kutch Hugh Pallin and Capt. Lester. Dr. Sálim Ali and others who followed in their surveys of Kutch or in bird ringing programmes failed to record *S. macrorhyncha*.

On receiving information from Mr. R.D. Jadeja (Range Forest Officer, Naliya) that he, along with Mr. Tejpal D. Shah, had seen a pair of bushchats, which they thought was Stoliczka's Bushchat, I went to Naliya in Western Kutch on January 4, 2002. Accompanied by Jadeja and Tejpal Shah, I went to the location where they had seen the birds. We came across the male in the morning and saw the female in the evening.

The male was in winter plumage and in both the birds the common features were the prominent long supercilium extending from the forecrown to behind the ear coverts and the distinct whiteness of their chins and throats. While the general behaviour of this species was similar to other bushchats, in the manner of gathering food one dissimilar feature observed conforms to what is stated by Roberts (1992) quoting Grimmett's personal communication, that after alighting on the ground after espying some insect, the bird would puff out its breast and start swaying it from one side to the other and then pick up an item of food. After moving on a little, the performance would be repeated once or twice. This behaviour was performed by both sexes. They also launched aerial sallies once in a while to catch some flying insect and at times darted vertically upwards. The puffing out of the breast feathers and the swaying motion on the ground give the appearance of a threat display, but it is more likely that this is a resort to flush out the insects from their sparse grass ground cover. The habitat preferred by this species consists of ground sparsely covered by short grass and dotted about by stunted bushes of *Prosopis chilensis* (= *juliflora*), *Ziziphus* sp. etc. To the north of the area under observation was a closely planted row of *P. chilensis*, beyond which were some closely planted vegetation and thick cover of grass. Stoliczka's Bushchat perched on the bare twigs of *P. chilensis* repeatedly, but scrupulously avoided entering the area of thick ground cover. After every foray for food, whether aerial or on the ground, these birds generally returned to the same perch. As described by Ali and Ripley (1973), the habits of this Bushchat are similar to the other members of the genus. However, owing to its extreme rarity, it has perhaps not been possible to study all aspects in this regard. The very fact that the species was observed in Kutch after a lapse of over a century and a quarter proves its rarity.

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22. OCCURRENCE OF THE GREY BUSHCHAT *SAXICOLA FERREA* (GRAY) NEAR NANJANAGUD, MYSORE DISTRICT, KARNATAKA

A male *Saxicola ferrea* was observed close to Narasambudhi lake, a large irrigation tank with a 2000 acre waterspread near Nanjanagud town (12° 5' N, 76° 43' E; 20 km south of Mysore city), on December 9, 2001.

The bird had a striking white supercilium and a black 'mask' around the eyes, ears and cheeks, whitish throat and a light grey wash on the underparts. Crown and back were a very dark grey, appearing almost black from a distance, but with faint brownish-white vertical striations at close range. The tail was black with faintly visible white edges. A white shoulder patch was distinct in flight, scarcely visible when alight. Bill and legs were blackish.

The bird was observed at 0745 hrs, hunting from a perch on an *Acacia leucophloea* tree beside the outlet canal of the lake, amid open area and close to a coconut grove. The surrounding area was open, partially irrigated land. The behaviour was characteristic of bushchats, but it was twice noted, unusually, to venture into the tree crown and feed like a warbler. This behaviour is atypical of bushchats and perhaps not common in this species, but we have observed it on two separate occasions previously in the Pied Bushchat *Saxicola caprata*.

The Grey Bushchat is "a common resident, subject to altitudinal and short-range seasonal movements. The Himalayas from NWFP to Arunachal Pradesh, thence south through Nagaland (?), Manipur, Meghalaya and Mizoram... Winters from.... into the Gangetic plain south to the Yamuna river and throughout Assam and Bangladesh" (Ali and Ripley 1987). It has been subsequently recorded from the Kanha National Park (Newton *et al.* 1986), Bandhavgarh National Park (Tyabji 1990) and Karera Bustard Sanctuary, all in Madhya Pradesh, and Bharatpur in Rajasthan (Kannan 1993). These represent the southernmost recorded extension of this species. The record from Nanjanagud is the first from southern India. The intense cold wave in northern India at the time of sighting might have been the cause for the flight of the bird so far south, where it is usually not found.

March 19, 2002

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23. EURASIAN LINNET (*CARDUELIS CANNABINA*), CHAFFINCH (*FRINGILLA COELEBS*) AND BRAMBLING (*FRINGILLA MONTIFRINGILLA*) IN KANGRA, HIMACHAL PRADESH

Three finch species described as vagrant to India, have been sighted in considerable numbers by me in the Kangra district, Himachal Pradesh. Between November 2001 and January 2002, I witnessed an invasion of Eurasian Linnet *Carduelis cannabina*, with a total of 131 birds on 7 occasions. Around Dharamsala, I had 12 sightings of Brambling with 20 birds in all between 1997 and 2001, while the Chaffinch *Fringilla coelebs* total was 91 birds in 33 sightings. Whistler (1926a, b) and Hingston (1920), who did extensive surveys in the district at the beginning of the 20th Century, did not note these species.

Eurasian Linnet (*Carduelis cannabina*)

Apart from one sighting of 3 at 2,400 m in the Dualadar (*sic*) foothills near Dharamsala, all the other Eurasian linnets occurred along the large Pong Dam Lake wetland in far southwest Kangra district, at 400 m. In Pakistan, where the Eurasian Linnet is described as an erratic winter visitor, the nearest point in its distribution is the NW Punjab (Roberts 1992), 250 km westwards. The site in Kangra lies between 31° and 33° N and 76° and 77° E.

Identification: Born and raised in the Netherlands, I have been very familiar with the Eurasian Linnet since childhood. On the day of the first sighting, on November 25, 2001, when surveying a part of the Pong Dam Lake, I thought that I heard a familiar guttural sound [quick "chuk-chuk-chuk, chuk-chuk-chuk"] while crossing the fields and mudflats at around 0700 hrs. Soon I saw the first troupes flying past, their forked tails and unmistaken call giving initial clues. Because they turn out quite shy, easily disappearing between the boulders and ditches when they settle, it took a while to get good views, but throughout the morning I was able to observe several small troupes. I noted the white rump and sides of forked tail, the dark wings showing white fringes at rest and whitish wing-patch in flight, streaked sandy under parts and streaked chin. Some were males and showed the chestnut of back and pinkish wash of breast, though on this first day I didn't get a very good view of the males. On later occasions, I did get good views of males (Table 1).

Table 1: Summary of the Eurasian Linnet sightings in Himachal Pradesh

Date	Number	Height (m)	Place
25.xi.2001	32	450	Nagrota, Pong Dam Lake
1.xii.2001	16	450	Haripur, Pong Dam
9.xii.2001	2	500	Jwali, Pong Dam
16.xii.2001	3	2400	Leta, Dharamsala
18.xii.2001	49	450	Nagrota, Pong Dam Lake
19.i.2002	1	450	Haripur, Pong Dam Lake
20.i.2002	1	450	Haripur, Pong Dam Lake

Behaviour: The observations at Pong Dam Lake concerned small flocks of 1 to 49, foraging on the mudflats, recently ploughed and sown fields, banks of boulders and stony ground with wild plants, always within half a kilometre of the receding shore of the lake. On the day with the highest total, on December 18, small troupes (1,6,1,8,6) were flying into the area from over the water of an arm of the lake into a southeast direction around sunrise (0700 hrs). Scattered flocks gradually swelled to larger flocks, eventually to a single troupe of 49. Flying birds constantly called their rapid "tjuk, tjuk,

Table 2: Summary of the Chaffinch sightings around Dharamsala

Date	Number	Height (m)	Place	Migration
26.x.1996	2	3300	Ilaka	
2.xi.1996	2	3300	Ilaka	
4.xi.1997	2	3300	Ilaka	
23.xi.1997	1	1200	Sidhpur	
27.xi.1997	1	1900	McLeod Ganj	
10.xi.1998	14	2800	Ghalu	
18.xi.1998	3	3300	Ilaka	
28.ii.1999	1	2600	Ghalu	N
23.iii.1999	2	2200	Dharnkot	
4.iv.1999	1	2200	Dharnkot	NW
24.x.1999	8	2800	Ghalu	First foraging; then SE
31.x.1999	1	2200	Dharnkot	
2.xi.1999	1	700	Gaggel	
7.xi.1999	6	2800	Ghalu	S
10.xi.1999	2	2200	Dharnkot	S
16.xi.1999	4	3300	Ilaka	SE (3 birds)
28.xi.1999	1	2700	Ghalu	
16.i.2000	1	2200	Dharnkot	
1.xi.2000	8	2200	Dharnkot	E-SE (7 birds)
7.xi.2000	5	2200	Dharnkot	SE (3 sep)
15.xi.2000	5	2400	Leta	E (4 birds)
28.xi.2000	1	2500	Leta	
15.xii.2000	1	800	Banoi	
2.iii.2001	2	2200	Dharnkot	
10.iii.2000	1	2200	Dharnkot	
9.xi.2000	2	1500	Indrunag	
25.xi.2000	1	2600	Ghalu	
29.x.2000	1	2200	Dharnkot	
11.xi.2000	2	800	Banoi	SE
2.xi.2000	1	1500	Indrunag	
2.iii.2001	2	2200	Dharnkot	
7.xi.2001	2	1900	McLeod Ganj	
9.xi.2001	1	1900	McLeod Ganj	
11.xi.2001	2	1900	McLeod Ganj	SE
29.xi.2001	1	1900	McLeod Ganj	

Table 3: Summary of the Brambling sightings around Dharamsala

Date	Number	Height (m)	Place	Migration
4.xi.1997	3	3300	Ilaka	
24.x.1999	1	2800	Ghalu	
7.xi.1999	2	2800	Ghalu	
10.xi.1999	1	2200	Dharmkot	East
16.xi.1999	2	3300	Ilaka	SE
3.i.2000	2	1300	Kanyara	
1.xi.2000	1	2200	Dharmkot	
7.xi.2000	1	2200	Dharmkot	
28.xi.2000	2	2400	Leta	SE
15.xi.2000	2	2400	Leta	
4.xi.2001	2	1900	McLeod Ganj	SE
8.xi.2001	1	1900	McLeod Ganj	

tjuk” or “chu, chu, chu”, often in rows of three syllables each, but also in rows of more syllables. Calls later in the morning, under the warm sun, were interspersed with the more musical notes that are part of their song.

The one observation from the higher parts of the district concerned 3 birds flying up from a bush-covered hillside at 2,400 m around 0800 hrs. This was the first clear morning after the first significant snowfall of the season and saw a strong southeastward movement of over 10,000 Hodgson's Mountain-Finch (*Leucosticte nemoricola*) and Altai Accentor (*Prunella himalayana*).

Having surveyed bird life in the higher parts of Kangra district since 1996 and only focusing on the lowest areas since 2001, I didn't come across the Eurasian Linnet before. It will be interesting to see whether more invasions take place in the future and whether like the Chaffinch (*Fringilla coelebs*) and Brambling (*Fringilla montifringilla*) we find indications of an expansion in their wintering range through the northwestern Himalaya.

Chaffinch (*Fringilla coelebs*)

The Chaffinch I have observed yearly around Dharamsala, mostly during migration time (Table 2). Identification was in most cases obvious through the double white wing-bars (white on lesser and greater coverts), greyish rump, dull brown underparts (female) and salmon underparts (male) with bluish-grey crown. Most of the birds that were seen perching called the characteristic, loud “tink, tink”, while several of the seemingly migrating ones often made a short stay in the treetops and called. In flight, they invariably made their soft “tup, tup” calls.

Brambling (*Fringilla montifringilla*)

Though less common than Chaffinch, the Brambling is also a regular migrant / winter visitor in small numbers (Table 3). While the dark head pattern and white rump are the most obvious field marks on which I conclusively identified some of these sightings, the characteristic call formed the basis for identification of the other sightings (apart from the typical nasal “gheeep” call, which all the birds sighted used the “tuk, tuk” call is different from the similar call of the Chaffinch). I am very familiar with all these calls from Europe.

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24. RECORDS OF SOME NEW AVIAN SPECIES IN THE THAR DESERT OF RAJASTHAN

The Thar desert, located in western India, is a predominantly sandy hot desert. It is unique because the fauna is an admixture of the Saharan, Palaearctic and Oriental elements. After the Indira Gandhi Nahar Pariyojana (IGNP) became operational, large-scale ecological changes have occurred in the desert, due to plantation in the canal area and creation of wetlands, some of them perennial, because of mismanagement and seepage of water.

This paper is based on four surveys conducted between November 2000 and February 2001 in Jaisalmer and Bikaner districts of Rajasthan. A study of the impact of ecological changes on the avifauna in the command area and its surroundings, revealed that a number of forest and aquatic birds never noticed about a decade ago are now common.

According to Rahmani (1997), the habitat changes in the area can be categorized into four groups: a. Change in crop pattern from subsistence farming to commercial farming;

Table 1: New records of birds in the Thar Desert, Rajasthan

S. No.	Common name	Scientific Name	Previous Record (Rahmani, 1997)	Author's Observation
1	Marbled Teal	*Marmaronetta angustirostris*	Not Reported	Ten individuals seen at 1140 RD, Escape Reservoir, Jaisalmer, 23.ii.2001
2	Ferruginous Pochard	*Aythya nyroca*	Eight birds from Gujarat, Guda-Vishnoian and Kolayat	Two individuals seen in IGNP Main Canal 15 km towards Sultana lake
3	Osprey	*Pandion haliaetus*	Not reported	One individual seen on Digga lake, Mohangarh, Jaisalmer, 24.ii.2001
4	Black Francolin	*Francolinus francolinus*	Only call heard, 15.vii.1993 near Lankaransar, Bikaner	One individual seen at Depression No. 7, 2.xii.2000
5	White-tailed Lapwing	*Vanellus leucurus*	Two birds in Gajner, 16.i.1994, three in Badopal, 19.i.1994. Two birds in Seepage water at 507 RD, 20.i.1994	Three individuals seen at 1356 RD, Escape Reservoir, Jaisalmer, 22.ii.2001
6	Black-headed Gull	*Larus ridibundus*	One bird near Sambhar Lake, 14.i.1991, three birds on seepage at 507 RD, 20.i.1994	Six individuals seen at 1140 RD Escape Reservoir, Jaisalmer, 23.ii.2001
7	River Tern	*Sterna aurantia*	Two individuals recorded in Guda Vishnoian, 7.iii.1994	Two individual seen at Digga Lake, Mohangarh, Jaisalmer, 24.ii.2001
8	Lesser Pied Kingfisher	*Ceryle rudis*	One individual seen inside Suratgarh town, 19.i.1994	Two individuals seen at 1356 RD, Escape Reservoir, Jaisalmer, 22.ii.2001
9	Small Blue Kingfisher	*Alcedo atthis*	One bird seen at village tank near Kolayat, 17.i.1994	One individual seen at Digga Lake, Mohangarh, Jaisalmer, 15.i.2001
10	Lesser Golden-backed Woodpecker	*Dinopium benghalense*	One individual seen near Rolsabsar, Fatehpur, Dist. Sikar, 4.ii.1993	Two individuals seen at 582 RD, Chhattargarh, Bikaner, 3.xii.2000
11	Grey-headed Flycatcher	*Culicicapa ceylonensis*	Not reported	Five individuals seen at 582 RD, Chhattargarh, Bikaner, 3.xii.2000
12	White-browed Fantail-Flycatcher	*Rhipidura aureola*	One bird seen near 820 RD, 21.i.1994; one bird seen near Mohangarh, 4.iii.1994; one bird seen near Chhattargarh in IGNP plantation, 15.vii.1994	Four individuals seen at 582 RD, Chhattargarh, Bikaner on 3.xii.2000
13	Oriental Magpie-Robin	*Copsychus saularis*	Not reported	One individual seen at 582 RD near Chhattargarh, Bikaner, 3.xii.2000
14	White-capped Redstart	*Chaimarrornis leucocephalus*	Not reported	507 RD heard in Bikaner, 4.xii.2000
15	Oriental White-eye	*Zosterops palpebrosus*	Not reported	Eight individuals observed at 582 RD near Chhattargarh, Bikaner, 3.xii.2000

b. Plantation on both sides of the canal and reservoirs; c. Seepage from canals has led to rise in the water table, and the formation of interdunal reservoirs has resulted in new wetlands, thus changing the ground cover from xerophytic and psammophytic to hydrophytic and mesophytic plants; d. Displacement of grazers to non-command areas has exerted pressure on the already overgrazed countryside. This changed scenario is now attracting many water loving birds to the hot desert.

No detailed systematic study was made of the avifauna of the Thar desert, till Rahmani (1997) reported 213 species of birds, of which nearly half, including water birds, are those that do not occur in the desert. In addition to the information from Rahmani (1997), the present study revealed five records of birds belonging to three families, observed for the first time in the area. They are, the Marbled Teal *Marmaronetta angustirostris*; Osprey *Pandion haliaetus*; Grey-headed Flycatcher *Culicicapa ceylonensis*; White-capped Redstart *Chaimarrornis leucocephalus* and Oriental White-eye *Zosterops palpebrosus*. Besides these, ten species belonging to six families have also been found to extend their range further west and southwest because of the suitable habitat. The details of observation by Rahmani (1997) and present sightings are given in Table 1.

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25. SIGHT RECORD OF POLYPHENIC FORMS OF *APPIAS ALBINA DARADA* C. & R. FELDER (LEPIDOPTERA: PIERIDAE) IN THE NILGIRI BIOSPHERE RESERVE

The Common Albatross *Appias albina darada* C. & R. Felder, protected under Schedule II of the Indian Wildlife (Protection) Act, 1972 (Anon. 1990), is one of the most abundant butterflies found at lower elevations in the Western Ghats. The species has a wide geographic range and is distributed almost throughout the Oriental Region (Larsen 1987). Both sexes are usually white, with the forewing having a narrow dark apical and a series of terminal markings. The females usually bear 4 to 5 additional apical white spots on the forewing.

During a recent study on insect diversity of New Amarambalam forests of the Nilgiri Biosphere Reserve, a few specimens of *A. albina* were collected from the banks of River Karimpuzha at Meenmutti located at an elevation of 650 m during February 2000. The females showed polyphenism and two forms, namely form *semiflava* and form *flava* besides the usual female form were collected. The details of the polyphenic forms recorded are given below.

A. albina darada* f. *semiflava: The underside of the forewing apex and that of the hind wing are yellow, instead of white. Although Wynter-Blyth (1957) states that this form is not rare, only 5 specimens could be collected from Meenmutti in this study. Of these, 3 specimens were collected on 8.ii.2000 and 2 on 9.ii.2000 (Coll. C.F. Binoy). The specimens are deposited in the Kerala Forest Research Institute (KFRI) collections.

A. albina darada* f. *flava: This form is yellow on both the dorsal and ventral side and has been reported to be 'very rare in South India' by Wynter-Blyth (1957). A single specimen was collected on 9.ii.2000 from the same locality as f. *semiflava*, and is deposited in the KFRI collections (Coll. C.F. Binoy).

Remarks

Occurrence of the polyphenic forms of *A. albina darada* coincided with the population build-up and migration of this species along with the pierids *A. indra shiva* Swinhoe. *A. wardii* Moore and *Cepora nadina remba* Moore in New Amarambalam during February 2000. It was interesting to note that these forms were not observed during rest of the year.

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26. ON A MISIDENTIFICATION OF THE MUD DAUBER WASP PARASITE *MACROSIAGON FERRUGINEUM* (FABRICIUS) (COLEOPTERA: RHIPIPHORIDAE) IN INDIA

During the course of my doctoral research on the phylogeny of the beetle family Rhipiphoridae, I found Srinivasan *et al.*'s (1999) note on the rearing of a rhipiphorid from the cells of eumenid wasps (Vespidae: Eumeninae) in India. The report is of great interest as very little is known about the bionomics and host preferences of rhipiphorids. However, the authors make several errors that lessen the value of this otherwise rare and important observation.

First and most importantly, the adult rhipiphorid pictured in Srinivasan *et al.* (1999) is not *Metoecus paradoxus* (Linnaeus) as the authors state, but quite likely *Macrosiagon ferrugineum* (Fabricius) given its host, locality, and colouration. *Metoecus* species are well known to be parasitoids of eusocial vespid wasps (Vespidae: Vespinae) (Heitmans and Peeters 1996, and references therein), not of solitary wasps as *Macrosiagon* species are (Falin 2002). Also, *Metoecus paradoxus*, a Palaearctic species, is unknown in India though several *Macrosiagon* species, including *Macrosiagon ferrugineum*, are (Csiki 1913). Judging from the authors' description and the photograph, the beetle's tawny yellowish or reddish dorsal surface and black ventral aspects are diagnostic of *Macrosiagon ferrugineum*, a widespread species found from southern Europe and northern Africa to the Indian subcontinent (Csiki 1913).

Srinivasan *et al.* (1999) are also incorrect in stating that theirs is the first record of a rhipiphorid reared from eumenine cells in India. Horne and Smith (1872) reported rearing a rhipiphorid beetle from a cell of *Eumenes esuriens* Fabricius from northwest India. The parasitoid was determined only to the genus *Emenadia* (= *Macrosiagon*), though again, judging from the illustration provided, I believe this to be another example of *Ma. ferrugineum*. Chobaut (1891) reared this species under the name *Emenadia flabellata* (Fabricius) from *Odynerus* spp. (Vespidae: Eumeninae) cells in France; it appears that this species parasitizes several related eumenid wasps in India as well.

Lastly, I cannot comment on the accuracy of the bionomic data provided by Srinivasan *et al.* (1999). However, I must add that contrary to the authors, rhipiphorids in the genera *Macrosiagon* and *Rhipiphorus* routinely successfully parasitize hymenopteran larvae within closed cells by using their mandibles to chew through the cell wall upon eclosion. True, they are occasionally trapped, particularly if the mud cells are unnaturally dried and hardened after being held in artificial laboratory conditions. Perhaps this is the phenomenon experienced by the authors.

I do not disparage the authors of their work. Rather, I encourage them and anyone to research the subject further and to continue reporting new information. Carefully reported collecting localities and dates, determination of host species, and other such bionomic facts regarding rhipiphorids would all be important and interesting additions to our knowledge of them. Rhipiphorids remain a fascinating yet poorly understood component of the Indian biota.

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27. OBSERVATIONS ON *LINGULA ANATINA* (LAMARCK 1801) FROM KARWAR WATERS, KARNATAKA, INDIA

Lingulate brachiopods are classic examples of living fossils that have survived almost unchanged for over 500 million years. Fossil records indicate that they are possibly the oldest living multicellular animals on earth. Despite their relative obscurity today, brachiopods have a long and rich palaeontological history. During the Palaeozoic era they were extremely abundant. They diversified morphologically, and even participated in the build-up of ancient reefs. At the end of the Palaeozoic era, about 250 million years ago, they were decimated in the worst mass extinction of all time, the Permo-Triassic event. Their numbers have never been as great since then.

Brachiopods are sessile marine animals that resemble common molluscs. Closer inspection shows their characteristics to be different, recognised as a separate Phylum Brachiopoda.

Description: Type species: *Lingula anatina* (Lamarck 1801).

Typical tongue-shaped structure, hence the name Lingulata (derived from Latin *lingula* = tongue-like). These are burrowing infaunal filter-feeders of the shallow inter-tidal zone. They burrow with the help of their muscular pedicle, which can be stretched up to 20 times its own length.

Habitat: In the present study, we came across *Lingula* inhabiting two different kinds of sediments, sandy and muddy / silty.

The site Amadalli is near a shore, where a small creek meets the sea. The sand is loose and coarse, and the *Lingula* seen here withdrew into their burrows at the slightest disturbance.

Kali estuary is brackish, being at the mouth of the tidal creek. Constant changes in the environment make this area a mixture of sandy and muddy / silty zones. *Lingula* tended to mainly inhabit the silty zone.

Table 1: Hydrological parameters recorded from July 2000 to January 2001

	Kali estuary	Manzil creek	Amadalli
Salinity (%)	0-27	0-27	12.31-33.21
Water pH	7.38-8.10	5.91-6.75	7.87-8.71
Sediment pH	8.10-8.70	5.93-6.77	7.79-8.70
Air temperature (°C)	24.78-27.50	26.29-28.5	25.21-28.23
Water temperature (°C)	24.4-27.0	25.5-29.7	23.4-28
Dissolved Oxygen (mg/l)	2.80-5.8	6.20-7.22	4.20-5.44

Manzil Creek, Chendiya – a brackish water creek – has silty sediment. The area is being utilized for aquaculture.

Associated flora and fauna: Amadalli has an abundant bivalve population. Kali, being an estuary, has all the typical associated fauna, including planktonic coelenterates, polychaetes, crustacean larvae, and meio- and macro-benthic fauna. Bivalves form the dominant molluscan fauna of fishery value. Fringing mangrove flora can also be seen. The abundant mangroves at Manzil creek were recently pruned for aquaculture. Crustaceans, molluscs, polychaetes, and coelenterates along with meio- and macro-benthic organisms form the main fauna of Manzil creek.

Collection of specimens:

Collection was carried out from June 2000 to January 2001. The area was scanned for 0.5-2 cm wide slits, which indicate the presence of *Lingula* in the burrow. Once the shell was caught, the animal was carefully removed from the burrow. A depth of more than 40 cm was reached before the animal was released.

Structure: Tongue-shaped, 2-shelled with extremely smooth surface, but with distinct growth lines, oblong, sub-parallel lateral margins, anterior margin slightly convex to straight with a median projection and long pedicle. Shell in adult specimens is 4-5 cm long and composed of calcium phosphate and chitin.

Colour: Greenish (translucent green to dark green), sometimes slightly beige to brownish along the lateral and posterior margins. Ventral valve has a pedicle groove, without visible growth lines and discontinuous with the internal sides of the valve.

Shell: Composed of 2 nearly identical valves located on dorsal and ventral surfaces of the animal. Anterior end truncate, posterior end tapers to a point where the pedicle is attached. Apex, the oldest part of the valve, is located at this point. Growth of young ones occurs anteriorly and laterally from the apex.

A fringe of bristle-like chitinous setae emerges from the margin of the valves. The shell is composed of chitin, protein and calcium phosphate, and is 50% organic matter.

Table 2: Size range of *Lingula* at the three study sites

	Shell length (mm)	Shell width (mm)
Kali estuary	20-40	8-18
Manzil creek	28-30	11-13
Amadalli	40-49	18-20

The outer surface is covered by a glossy, proteinaceous periostracum. The high percentage of organic material makes the shell relatively flexible and soft.

Lining the inside of the valves is the mantle, which secretes the shell, and encloses the mantle cavity. Within this cavity is the lophophore, with cilia that beat and give rise to a water current that helps the animal in feeding and respiration. The animal occupies only the posterior part of the shell.

Pedicle: A long extension of the body, which is used to anchor the animal in its burrow. The epithelium of the posterior end of the pedicle secretes glue-like mucous that adheres to the sediment in the bottom of the burrow, thereby temporarily anchoring the animal. Lingulids are not permanently anchored and can change position. Pedicle contains an evagination of the coelom and is hollow. Pedicle length varies and hence is not considered for comparison.

Discussion: On the basis of various morphological characters, the animal was identified to species level. In these waters, *Lingula* is found in two types of habitat, sand and silt. Better growth and survival was noted in the sandy area. *Lingula* collected from Amadalli were larger than those collected from Kali estuary and Manzil creek. According to Emig *et al.* (1978) too, lingulids usually inhabit sandy marine bottoms from the inter-tidal to the circa-littoral zone.

There are various contradictions concerning the burrowing behaviour of *Lingula*. Emig (1983) mentioned the non-reburrowing characters in Asamushi, Japan, but Hyman (1959) and Savazzi (1991) say that it is capable of reburrowing.

At the time of collection the animal was found burrowing deeper and hence the pedicle length was seen to vary greatly. Emig (1983) mentions that the pedicle can attain a length 20 times greater than its shell.

The maximum shell length found at Amadalli was 49 mm (Table 2), whereas according to Mahajan and Joshi (1983) the maximum shell length (SL) was 47.56 mm. Yatsu mentions the maximum length of Japanese *Lingula anatina* as 35 mm (Hyman 1959). This indicates that Indian species are much larger in size.

The *Lingula* found here are adaptable as the highly fluctuating parameters appeared to have very little effect on the animal (Table 1).

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28. *MUCUNA SEMPERVIRENS* HEMSL. (LEGUMINOSAE: PAPILIONOIDEAE) – A NEW REPORT FOR ARUNACHAL PRADESH

Recently, during a botanical exploration in Dibang Valley, Arunachal Pradesh, we collected an interesting specimen of *Mucuna* (*c.* 1300 m, 18.xi.2000, *M.K. Pathak & M. Bhaumik* 3204-CAL) *c.* 26 km north of Roing on the way to Myodia Pass. A critical study revealed that it was *Mucuna sempervirens* Hemsl., hitherto unreported from Arunachal Pradesh.

A brief description of our collection and other relevant data are given to facilitate its identification in the field.

Mucuna sempervirens Hemsl. in Forbes & Hemsl., J. Linn. Soc. Bot. 23: 190. 1887 & in Curtis Bot. Mag. *t.* 7978. 1904; Grierson in Grierson & Long (eds.), Fl. Bhutan 1(3): 686. 1987; Wilmot-Dear in Kew Bull. 39: 39. 1984 & 42: 27. 1987; Sanjappa, Leg. India 218. 1992. *M. mairei* H. Lev. In Feddes Repert. 13: 337. 1914. *M. japonica* Nakai in Bot. Mag. Tokyo 46: 57, 631. 1932.

Woody climber; stem longitudinally ridged, glabrous. Racemes arising from leafless older stems, 10-15 cm long, *c.* 10 flowered. Pedicels *c.* 2.5 cm long, pubescent; bracteoles deciduous. Calyx 8-12 x 18-25 mm, cup-shaped. Corolla dark purple; standard 3.2-4 cm long, keel 6-7 mm long. Staminal tube *c.* 4 cm long. Ovary and style pubescent.

Fl. & Fr.: May-October.

Distribution: INDIA: Arunachal Pradesh, Manipur, Sikkim, West Bengal; Bhutan, China, Myanmar.

Notes: The plant was found growing in subtropical forest at an elevation of *c.* 1,300 m on humus-rich soil, beside a stream. The area experiences heavy rainfall and the plant was found to reach the top of the forest canopy. We could not locate the species in any other locality of Dibang Valley.

A copious amount of watery sap was found to ooze out on cutting the stem.

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We are grateful to the Director, Botanical Survey of India, to Dr. M. Sanjappa and Dr. S.K. Verma for help and encouragement.

November 15, 2001
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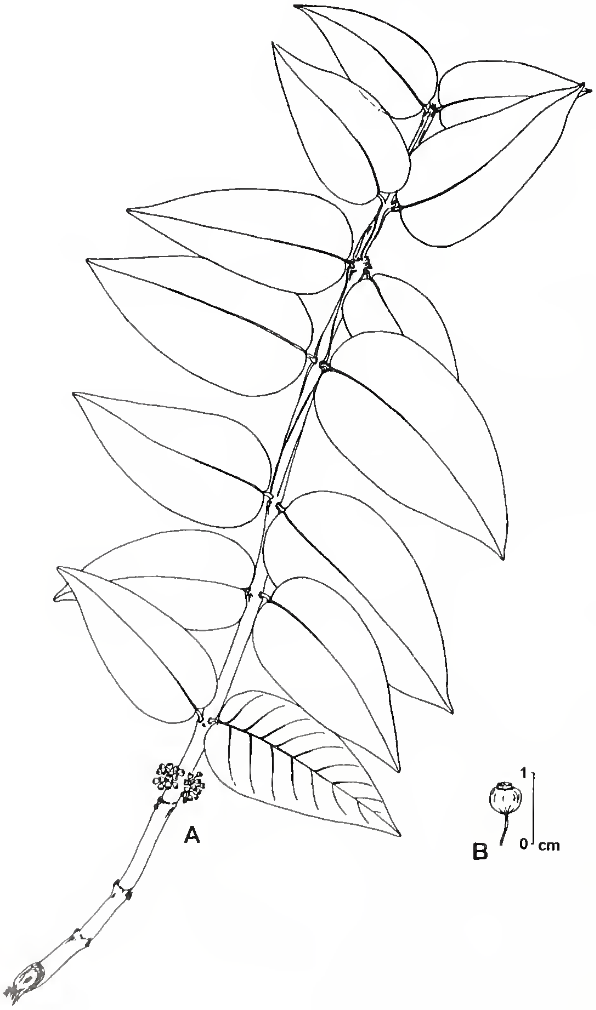
29. *MEMECYLON WIGHTII* THW. (MELASTOMATACEAE), A NEW RECORD FOR MAHARASHTRA STATE

During studies on the flora of Savantwadi taluka and thereafter Chaukul and Ramghat area of Sindhudurg district of western Maharashtra, a number of interesting flowering plants were collected. A rare plant belonging to the genus *Memecylon* of Family Melastomataceae drew the attention of the author. Critical study of the collected materials confirmed its identity as *M. wightii* Thw.



Nomenclature, a short description and differences between the related species are given in the note. Illustrations of flowering twig and a fruit are provided (Fig. 1).

Memecylon wightii Thw., Enum. 113. 1859; Cogniaux in DC., Monogr. Phan. 7: 1145.1891; C.B. Clarke in J.D. Hooker Flora British India 2: 554. 1897; Woodrow in J. Bombay Nat. Hist. Soc. 11: 638.1898; Cooke, T. The Flora of the Presidency of Bombay 2: 503.1903; Talbot, Forest Flora of the Bombay Presidency and Sindh 2: 55.1911.

A small tree; branchlets slender, quadrangular, winged; wings broader between each node. Leaves shortly petiolate, ovate-oblong, acute or somewhat acuminate, glabrous, thick, shining above, penninerved beneath. Flowers crowded cauliflorous, borne on the bare basal portion of the branchlet in between two nodes, pedicellate; pedicel slender, tube campanulate; limb slightly 4-lobed or almost truncate. Petals blue, obtuse. Berry spherical, conspicuously crowned with the calyx-limb.

M. wightii Thw. resembles *M. randerianum* Almeida & Almeida in general appearance, however, it varies from *M. randerianum* in the following characters.

M. wightii Thw.	*M. randerianum* Almeida & Almeida
1. Branchlets quadrangular winged.	1. Branchlets terete.
2. Leaves shortly pedicellate, rounded at base.	2. Leaves sessile, amplexicaule
3. Flowers cauliflorous in clusters.	3. Flowers axillary.
4. Pedicel very slender, pendulous, peduncle absent.	4. Pedicel stout, peduncle erect.

Fl: January.

Fr: September.

The materials collected from an evergreen forest near the Amboli-Chaukul border are preserved and deposited at Blatter Herbarium. (Specimens No. BGG 1050, 2628).

There is no report of this species from the present State of Maharashtra. Nor are there any specimens in Blatter Herbarium, Mumbai.

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January 22, 2002

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30. *LEPTOLEJEUNEA BALANSAE* STEPH. (HEPATICAE: JUNGERMANNIALES) – A NEW RECORD OF BRYOFLORA FROM THE INDIAN MAINLAND

The Western Ghats in peninsular India – recognized as one of the richest biodiversity hotspots in the world – has been studied well for flowering plants. The Tirunelveli-Travancore hills, located at the southern end of the Western Ghats and lying in the states of Tamil Nadu and Kerala respectively, are perhaps the richest in the Western Ghats. The flowering plants, and ferns and their allies have been well documented, but lower groups remain greatly neglected. Therefore we began collecting the bryophytes of the Western Ghats of Tirunelveli and Kanyakumari districts, three years ago, with the intention of compiling an inventory. *Leptolejeunea balansae*, a folicolous liverwort, earlier known to occur only in the Andamans in India (Pande *et al.* 1957; Awasthi 1986) was recorded from the study area. A detailed description and an illustration are provided.

Leptolejeunea balansae **Steph.** in Hedwigia 35: 105. 1896 & Sp. Hepat. 5: 377. 1913; Pandé *et al.* in J. Indian Bot. Soc. 36: 345. 1957; U.S. Awasthi in J. Indian Bot. Soc. 65: 119.1986 (Fig. 1).

Plants dioecious, folicolous, closely appressed to the substratum, 2-10 mm long, green. Leaves distant, spreading obliquely, slipper-shaped, 0.35-0.4 x 0.17-0.19 mm, entire along

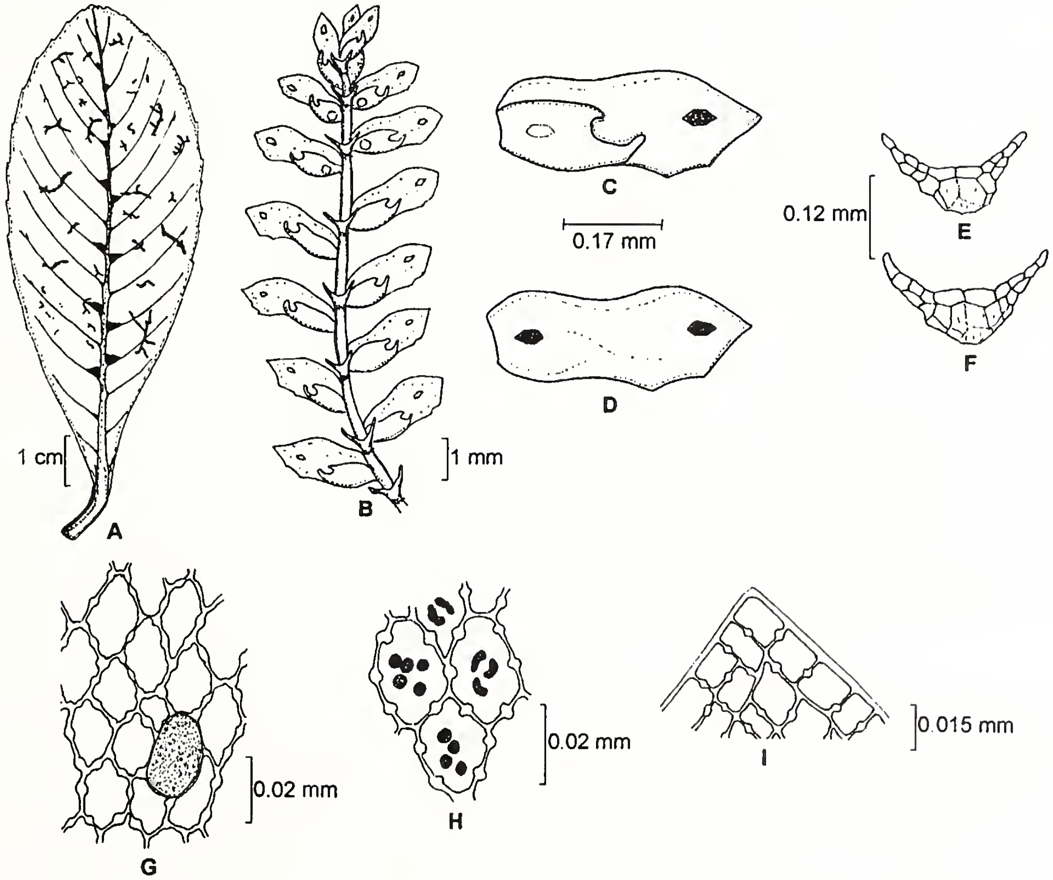

Fig. 1: *Leptolejeunea balansae* Steph.; A. Leaf showing thalli, B. Thallus with antheridia, C. Leaf with lobule showing the upper ocellus, D. Leaf without lobule showing both the ocelli, E. & F. Under leaves, G. Leaf cells with an ocellus, H. Leaf cells with oil bodies, I. leaf apex

the margins, 2-dentate towards the apex on the ventral side; marginal cells 13-15 x 14-16 µm median cells 20-22 x 16-18 µm; basal cells 23-25 x 19-21 µm; walls 3-gonous, hyaline, with nodular thickenings in between; oil bodies 2-5 per cell, rounded or elongate, 5-7 µm, granular, translucent, green; ocelli 2 per leaf; apical one *c.* 30 x 20 µm; basal one *c.* 33 x 21 µm; lobules about half as long as the leaves, toothed. Underleaves deeply 2-lobed; lobes distant, widely spreading; cells 2-seriate at the base, uniseriate above; base somewhat quadrate, *c.* 0.04 x 0.15 mm; central zone with a tuft of hyaline rhizoids. Antheridia terminal, on the main stem or lateral branches towards apex, *c.* 60 µm, light brown. Female plants not seen. (Not seen by earlier workers either, *vide* Awasthi *l.c.*).

Habitat: Grows on the upper surface of leaves of *Elaeocarpus venustus* Bedd. (Elaeocarpaceae), a large evergreen tree. *Elaeocarpus venustus* is endemic to the study area and adjoining areas in Kerala and is known by a small population (Henry and Swaminathan 1978). It has been categorized as a vulnerable (Nayar 1996) and endangered species (Gopalan and Henry 2000). We observed 10 trees in a swampy area.

Though earlier workers described *L. balansae* as folicolous, there is no mention of the host species. In the Andamans material examined by us, in one collection the host plant is a fern *Angiopteris evecta* (Forst.) Hoffm., and in the other it is a dicot *Heritiera littoralis* Dryand (Sterculiaceae), both of which are widespread. In the present study, so far, the endemic *E. venustus* is the only known host. In the first collection of about 50 leaves from a branch, only one had 31 plants, most measuring less than 6 mm. In the second collection of about 100 leaves from a branch, only one had 15 plants measuring less than 6 mm. As a result, finding the plant seems a matter of chance despite one's best efforts.

Distribution: INDIA: Andaman Islands and Tamil Nadu; Malaysia, Thailand and Vietnam (Awasthi, *l.c.*).

Note: The host leaves of the Andamans material have 110, 68 and 27 plants in an area of 60, 52 and 61 sq. cm respectively, whereas the host leaves under study harbour 33 and 3 plants in an area of 24 and 20 sq. cm respectively. This density is considerably lower than that of the Andamans specimens. The larger size of the Andamans specimens (plants measuring up to 15 mm, leaf lobes 0.48-0.64 x 0.17-0.32 mm, leaf cells 12-52 x 16-29 µm and ocelli 50-71 x 29-33 µm) is perhaps due to the higher annual rainfall and humidity in the Andamans than in the Western Ghats.

Specimens examined: India, Andaman Islands, prope Port Blair, 1895, *E.H. Man s.n.*; prope Port Blair, 1895, *E.H. Man s.n.* (G). Tamil Nadu, Kanyakumari dist., W. Ghats, Upper Kodaiyar, evergreen forests, epiphyllous on *Elaeocarpus venustus* tree, *c.* 1,250 m, 9.xi.2000, *A.E.D. Daniels* 1218; 24.viii.2001, *A.E.D. Daniels* 1802 (MH, SCCN).

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Cover Photograph: Saltwater Crocodile *Crocodylus porosus*
By Romulus Whitaker

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Editorial

A need for Species Recovery Plans

The Wildlife (Protection) Act was enacted in 1972, and since then has been modified several times, the latest being in 2003. This Act is supposed to take care of all our protected areas, wild places and wild species. The Act also covers The Wildlife (Transactions and Taxidermy) Rules, 1973; The Wildlife (Stock Declaration) Central Rules, 1973; The Wildlife (Protection) Licensing (Additional Matters for Consideration) Rules, 1983; The Wildlife (Protection) Rules, 1995; The Wildlife (Specified Plants – Conditions for Possession by Licensee) Rules, 1995; The National Zoo Policy, 1998; and The Declaration of Wildlife Stock Rules, 2003.

The 42nd Constitutional Amendment Act, 1976 was a landmark decision when for the first time the subject of wildlife was inserted as Entry-17B in the List-III (concurrent list) of the Seventh Schedule of the Constitution. With rapid changes in the perception of wildlife conservation in the world, the Wildlife (Protection) Act, 1972 has been appropriately amended in 1982, 1991, 1993 and 2003.

The wild species of flora and fauna are listed in various schedules (I to V), with the most threatened species listed in Schedule I. But, is it so? If you go through the species lists, the Act is heavily biased towards mega-vertebrates – some of the rare amphibians, reptiles, fish, and insects are left out. The listing is unfortunately not based on any objective scientific assessment of threats to a particular species.

Our suggestion to the Government of India is that this listing of species in different schedules should be done purely on the basis of scientific assessment, and for species that are listed in Schedule I and Schedule II, there should be species recovery plans. It is no use just listing the species, and then forgetting about them. Our aims should be to see that species recover to such numbers that they are downlisted from Schedule I to Schedule II, and from Schedule II to III or IV. That will be some achievement. We have some examples of success stories. For instance, Blackbuck (*Antilope cervicapra*) has recovered in many areas and it is not so rare as it used to be 30 years ago. Moreover, like most ungulates, it has tremendous breeding potential. Should it not be downlisted to Schedule II? Even in Schedule II, it will remain legally protected. Similarly, Chinkara (*Gazella bennettii*) is widespread in north and central India, and is abundant in many Bishnoi areas of Rajasthan, Punjab and Haryana. It is found in at least 11 states and more than 150 sanctuaries. There could be as many as a hundred thousand Chinkara in Rajasthan alone. With such a large population, should it be included in Schedule I at all? Are we not diluting Schedule I by including such common and widespread species? Interestingly, Ermine (*Mustela erminea*), a widespread species in the temperate regions of the world, is included in Schedule I. Or take the case of Leopard (*Panthera pardus*), it is the most widespread of large cats in the world (present in Africa, the Middle East and Asia). Undoubtedly many subspecies or populations of Leopard are critically endangered and need every possible conservation support to survive. They are under great poaching pressures, but can we say that the species is threatened with extinction? Can we equate it with the Hangul (*Cervus elaphus hanglu*) or the Pygmy Hog (*Sus salvanius*) or the Asiatic Lion (*Panthera leo persica*) that have only one known viable population each?

It should be compulsory for the Central and State governments to start species recovery plans for all the species listed in Schedule I. These species recovery plans should be based on good science and should have a time frame, say 10-15 years (most endangered species would take that long, perhaps longer, to recover at the current level of disturbances). Some thinly distributed species that need a wider landscape to survive may never recover so they would need targeted conservation actions. The classical examples are the Great Indian Bustard (*Ardeotis nigriceps*) and Lesser Florican (*Sypheotides indica*) that need grasslands, or the Gangetic Dolphin (*Platanista gangetica*) that requires clean, unpolluted and undisturbed rivers. For such species there should be special central government schemes, much like Project Tiger and Project Elephant.

We also have to develop a different approach for the conservation of our floral diversity. The IUCN criteria and categories valid for fauna are not very suitable for plants. Similarly, for commercial fish and marine species, we need not include all of them in various schedules of the Wildlife Protection Act but devise a sustainable approach for conservation. Perhaps local communities, in this case fishermen, have to be empowered to conserve their biotic resource. What I want to emphasize is that there is no single solution for saving species, and certainly including threatened and not so threatened species in Schedule I or Schedule II is not the answer to emerging conservation needs and initiatives. Listing in various schedules should be dynamic as it requires regular reassessment.

I also feel that an attempt must be made to make the plants and animals mentioned in the schedules easily identifiable. It serves no purpose unless the animal and plant mentioned in the schedule has a sketch or photograph of the animal or plant along with the name(s). It is therefore necessary to publish an identification catalogue wherever possible, so that anyone, including the enforcement authorities such as the Forest Department, Police, Customs and Coast Guards, can readily identify the species mentioned in the Act.

The Ministry of Environment and Forests (MoEF) should start an exercise to recheck various species listed in schedules, by involving experts and wildlife research institutes. Let all those species about which we do not have sufficient population data, which are suspected to be rare or declining, be in higher schedules on the basis of the precautionary principle, but those species which are not so uncommon, should be down listed (but should remain protected). The IUCN method of assessment of a species status is very simple and scientific. Let us follow this method and reassess all the species listed in various schedules of the WPA, and if we find that there is a need to change the status of a species, we should not hesitate to do so. Once this exercise is over, for all the species that are finally listed in Schedule I, there should be centrally funded, science based species recovery plans, involving the cooperation of conservation institutes, local communities, experts and government departments.

ASAD R. RAHMANI

With inputs from Mr. P.K. Manohar, Trustee, LAW-E

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A CASE STUDY OF THE SALTWATER CROCODILE *CROCODYLUS POROSUS* IN MUTHURAJAWELA MARSH, SRI LANKA: CONSIDERATIONS FOR CONSERVATION[1]

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Muthurajawela Marsh - Negombo Lagoon is a 6,300 ha complex consisting of a brackish marsh and a shallow lagoon, located just 20 km north of Colombo, the capital of Sri Lanka. I located and studied a small, remnant population of saltwater crocodile (*Crocodylus porosus*) in this complex. The total number of adults is estimated to be 15 individuals (estimated up to 33 individuals at a 95% C.I.), and this population is still reproducing. Human activities are reducing breeding success in the otherwise suitable habitats (reed islands, mangrove forest), directly (hunting and fishing), and indirectly (habitat modification). Killing of nest-guarding female crocodiles and capture of juvenile crocodiles in "brush piles" are the two most detrimental hunting practices. Better understanding of these small-scale processes may help explain the gradual decline of saltwater crocodiles on a large scale in Sri Lanka, and offer guidance for developing effective conservation programmes.

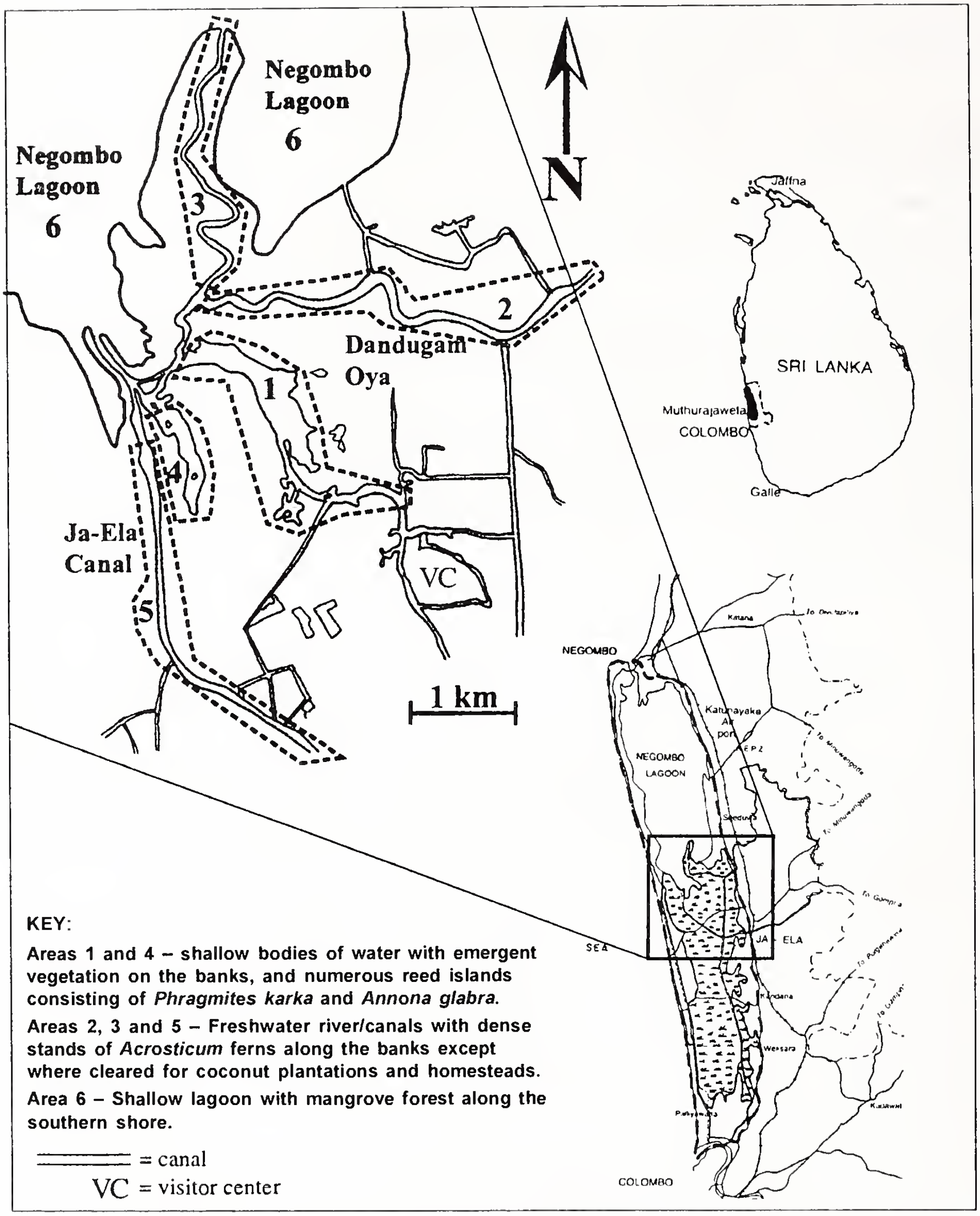
Key words: Conservation, crocodile, *Crocodylus porosus*, Sri Lanka, wetland

INTRODUCTION

Two species of crocodile, the mugger or marsh crocodile (*Crocodylus palustris*) and the saltwater crocodile (*Crocodylus porosus*), inhabit Sri Lanka. Historically, information on the status of these species in Sri Lanka has been scanty (Deraniyagala 1953, Whitaker and Whitaker 1979), but for some recent data (Porej 1997a, Santiapillai *et al.* 2000, Santiapillai and de Silva 2001). Both crocodile species are currently listed in Appendix I of CITES for Sri Lanka (Convention of International Trade in Endangered Species of Wild Fauna and Flora). Santiapillai and de Silva (2001) estimate the total number of saltwater crocodiles in Sri Lanka to be perhaps no more than 300, and suggest that this species be considered "critically endangered" within Sri Lanka.

Saltwater crocodiles are the most widely distributed of the crocodilians, ranging from southern India and Sri Lanka, throughout southeast Asia and the Indo-Malay Archipelago, to the Philippines, New Guinea and northern Australia (Ross 1998). Their status is highly variable, from being virtually extinct in some countries (Singapore, Thailand) to abundant in others (e.g. Australia). Although there are numerous national parks in Sri Lanka, and crocodiles are protected by the Fauna and Flora Protection Ordinance of 1938, there are no conservation or management programmes in place. Saltwater crocodiles have been extirpated or severely reduced in several areas around the island, and persist mainly in isolated patches of suitable habitat, and remote areas where human activity is still low (Whitaker and Whitaker 1989, Porej 1997a, b). Fishing, hunting and habitat modification were identified as leading causes for the decline of saltwater crocodiles in Sri Lanka (Uragoda 1994, Santiapillai and de Silva 2001). Illegal crocodile hunting occurs in most of the 26 wetlands surveyed by Porej in 1997 (Porej 1997b, see also Santiapillai and de Silva 2001). In a recent synthesis of crocodile data from Sri Lanka, Santiapillai and de Silva (2001) documented crocodile decline and noted that the amount and distribution of protected areas in the western, southwestern, and southern areas of the island remain inadequate. Obtaining quantitative data on saltwater crocodile distribution and abundance in Sri Lanka has been identified as a high priority by the IUCN Crocodile Specialist Group (Ross 1998).

The saltwater crocodile population of the Muthurajawela Marsh-Negombo Lagoon complex (MNLC) inhabits an area in which some prime habitat remains only because the area's physical characteristics (constant flooding, poor soils, difficult access) render it unsuitable for agriculture and large-scale timber exploitation. Like many other river estuaries on the western and southern Sri Lankan coast, where saltwater crocodiles still persist (Porej 1997a, Santiapillai *et al.* 2000), this area is almost completely isolated by surrounding human activities (Samarakoon and van Zon 1991). It is likely that massive residential and industrial developments, which tend to concentrate in these areas, disrupt normal migratory patterns along the upstream waterways (Ross 1998). In addition, crocodile populations in areas such as the MNLC face increased hunting pressure as the surrounding human population increases, and road developments provide access to previously inaccessible crocodile foraging and breeding grounds.


Negombo Lagoon 6
Negombo Lagoon 6
3
2
Dandugam Oya
1
4
Ja-Ela Canal
5
VC
1 km
N
Jaffna
SRI LANKA
Muthurajawela
COLOMBO
Galle
NEGOMBO
Katana
Katunayaka Air port
EPZ
NEGOMBO LAGOON
Seeduwa
SEA
JA - ELA
Kandana
Welisara
Peliyagoda
COLOMBO

KEY:

Areas 1 and 4 – shallow bodies of water with emergent vegetation on the banks, and numerous reed islands consisting of *Phragmites karka* and *Annona glabra*.

Areas 2, 3 and 5 – Freshwater river/canals with dense stands of *Acrosticum* ferns along the banks except where cleared for coconut plantations and homesteads.

Area 6 – Shallow lagoon with mangrove forest along the southern shore.

═══ = canal
VC = visitor center

Fig. 1: Map of Muthurajawela Marsh- Negombo Lagoon complex, Sri Lanka, showing the location of six survey areas

This case study investigates the effects of human activities on crocodile distribution, breeding activities and population numbers on a local scale. Questions of interest are: How much overlap exists between fishing areas and suitable crocodile breeding habitat in estuarine regions such as MNLC? Do relatively low-impact, small scale hunting and fishing practices affect local crocodile populations? If so, what are the most detrimental fishing/hunting practices, and how can they be modified to allow the coexistence of man and crocodile? Better understanding of these local processes can help explain the gradual disappearance of saltwater crocodiles on a large scale from Sri Lanka, and help devise more effective conservation plans.

STUDY SITE

The Muthurajawela Marsh-Negombo Lagoon complex (MNLC) is located *c.* 20 km north of Colombo, capital of Sri Lanka. It consists of the Muthurajawela marsh, a large area of brackish marshes (3,100 ha) on the southern end, and the shallow (avg. depth 0.65 m), estuarine Negombo lagoon (3,200 ha) to the northwest (Fig. 1). The lagoon opens into the sea by way of a single opening at the northern end.

The Muthurajawela marsh consists of previously cultivated rice paddy fields, a network of canals, scattered ponds and cultivated fields. Most of the Muthurajawela marsh is flooded during the periods of heavy rain, and the poorly drained peat substrate is saturated almost the whole year. Large areas of natural vegetation still exist, particularly in the northern segment of the marsh. The southern portion of the marsh is dominated by a combination of sedges and cattails. Also common are patches of ferns (*Acrostichum aureum*) and an invasive, exotic shrub *Annona glabra*. Mangroves still fringe some segments of the lagoon shoreline.

The MNLC harbours immense bird diversity (146 resident and 35 migrating species) and is productive enough to support over 3000 fishermen (Samarakoon and van Zon 1991). In addition to saltwater crocodiles, it provides habitat for an assemblage of wetland-dependent reptiles and amphibians. These include two species of monitor lizards, two endangered terrapins, and the extremely rare Gerard's water snake *Gerarda prevostiana* (Porej 2001).

The study site was divided into 6 study areas differing in physical characteristics (Fig. 1.) and ranging from river and canal (areas 2, 3 and 5) to shallow, slow-flowing or stagnant open water bodies (areas 1, 4 and 6). These areas also differ in the amount of housing and the intensity of fishing activities. Most houses are located along the banks of the Dandugam. Oya River and the Ja-Ela canal. Of 173 houses located within the boundaries of the study site, 135 (78%, 22.5 houses/km riverbank) are located along the canal in area 5; 17 houses are located in area 2 (9.8%, 4.7 houses/km riverbank); and the rest are squatters' houses scattered throughout the more remote areas (Samarakoon and van Zon 1991, Benthem and van Zon 1994).

Fishing methods include push nets, seines, cast nets and brush piles, (Samarakoon and van Zon 1991). Brush piles and harvesting of females guarding a nest are two methods by which crocodiles are captured in the MNLC. Brush piles are fish-aggregating devices, constructed by forming a 5-6 m diameter circle of upright sticks in shallow water, and filling it with small branches and leaves. Decomposing material attracts many small fish and shrimp to these sites, which in turn attract large fish favoured by fishermen. After a period of 30-45 days brush piles are surrounded by fishing net, the branches removed, and the fish captured by hand or hand-held nets. Quite often, juvenile crocodiles take refuge in these 'havens' and become a welcome addition to the fisherman's diet. Adult crocodiles taken are mostly females killed while guarding a nest. When a nest is discovered, the fishermen will return to the site until they locate and kill the female. If the eggs are recently laid, they are collected for consumption, and if not, the nest is usually set on fire.

MATERIAL AND METHODS

Study areas were surveyed eight times from May 7 to August 18, 1997. Surveys were carried out at night from a boat moving at constant speed (*c.* 10 km/h), using a 1 million candlepower searchlight (for a detailed description of night-time survey techniques and techniques for the capture and restraint of crocodilians see Bayliss 1987 and Crocodile Specialist Group 1994). Every 20 minutes of the survey, water and air temperature, cloud cover, tide level and wind speed were recorded, along with a short description of the physical features (bank characteristics, vegetation, wind, light and tide level). These data are available upon request. Surveys were carried out within 3 hours of low tide, but due to abundant vegetation, low tide usually exposed only 20-30 cm of bank.

An observed crocodile was approached until it submerged or was captured. Observation distance (distance from the observer to the crocodile) was recorded, and detected individuals were entered into one of four size categories (adapted from Crocodile Specialist Group 1994) of estimated total lengths shown in Table 2. In Sri Lanka, saltwater crocodiles reach sexual maturity by the time they are 1.7 to 2.7 m in total length (see Deraniyagala 1953, Santiapillai and de Silva 2001). Animals less than 50 cm long were classified as juveniles, and animals in the range of 50-200 cm were considered sub-adults. Animals that were not approached close enough to record exact size were recorded as "Eyes only" (E.O). Adult crocodiles are wary of humans, and individuals in this group were almost always large, exceeding 2 m in length, which submerged within moments of being spotted. Records of "Eyes only" were therefore added to the adult count (Webb and Messel 1979, Sah and Stuebing 1996). Captured individuals were measured (total length, SVL, weight) and marked by clipping a combination of dorsal scutes, then released. No individuals were recaptured.

The calibration method of Messel (1979), and Messel and Vorlichek (1989) was used to estimate adult population in the MNLC. Because of the constant fresh water input, this complex would be considered a Type I waterway in their classification, and appropriate calibration formulas were used (Webb and Messel 1978). Differences in observation distances among study sites were examined using one-way ANOVA after testing for homogeneity of variance using Bartlett's test. A Spearman rank order correlation test was performed on the ranked scores for the adult and non-adult (juvenile and sub-adult densities combined) densities observed within an area. Means are followed by ±1 SD, unless noted otherwise.

Active (with eggs) and inactive nests were located by interviewing fishermen, using boats or by walking along shores, riverbanks, and canals with permanent water, and looking for a smooth slope with slide marks into the water or well-worn tracks. Previous studies have reported that female *C. porosus* may build multiple nests (Webb *et al.* 1983), and therefore the extent to which the located nests reflect the total number of nests in not known.

The number of brush piles was recorded during each survey, and an average was calculated for each study area. As a part of a different study (Porej 2001) most study areas of the marsh were visited every day, and during these visits every instance where a fish net was placed across the entire width of the northern entrance to areas 1 or 4 was recorded.

RESULTS

Crocodile survey

The mean number of crocodile sightings was 11 ±3.8 per survey (Table 1). Juveniles and sub-adults made up 78% of the total sightings (Table 2). Mean observed densities were 0.21 ±0.1 individuals/km for adult crocodiles and 0.73 ±0.6 individuals/km for juveniles and sub-adults combined. The highest density of adults was recorded in areas 2, 3 and 4, and non-adult density was highest in areas 2 and 4.

The average distance from which a crocodile was first observed was 26 ±11 m. There is no significant difference in average observation distance among study areas ($F_{5, 81}$ 0.507, p = 0.23, one-way ANOVA). There was a statistically significant correlation between adult and non-adult densities observed within each area (r = 0.89, p = 0.015, df = 4, Spearman rank-correlation test). A notable outlier is area 3, which had a lower density of non-adults than would be expected from the observed adult density (adult density ranked 1st and non-adult density ranked 3rd).

Table 1: Crocodile sightings during 8 surveys from May to August 1997 in MNLC

	Survey Area							
Survey date	1	2	3	4	5	6	Total adults	Total (non adults)
May 7-8	1	3	2(1)	2	2	0	1	9
May 19	1	11	1	2(2)	-	-	2	13
May 26-17	2(2)	12(4)	-	0	1	0	6	9
June 5	1	-	3(2)	2	2(2)	2	4	6
June 19-20	1	-	2	0	-	3(2)	2	4
July 3-4	2	6(1)	2	1	1	1	1	12
August 2-3	0	4	-	1	2	-	0	7
August 18	1	5(1)	4(2)	2	-	0	3	9
Density (adults)	0.14	0.33	0.33	0.28	0.07	0.11	0.21	
Density (non-adults)	0.39	1.94	0.60	1.00	0.20	0.22		0.73

Number of adults and "Eyes Only" individuals are given in parenthesis. Density is expressed as number of individuals/km of shoreline surveyed.
Waterways not surveyed are marked "-".

The total number of adult crocodiles inhabiting the marsh is estimated at 15 (the 95% C.I. estimates the number of adults to be up to 33). During the additional three surveys of Dandugam Oya upstream from Muthurajawela, only two adult crocodiles were observed over 32 km of river surveyed.

A total of 11 nests (9 active) were recorded (Table 2), only two of which were successful.

Fishing

The average density of brush piles was 5.2/km in area 1, 2.3/km in area 4, and less than 0.8/km in remaining areas. Fishing nets were cast across the entire canal width at the entrance to area 4 for 17 days (out of 107 days), and for 65 days at the entrance to area 1.

DISCUSSION

Compared to the results from other standardized saltwater crocodile surveys for these types of systems (e.g. Bayliss and Messel 1988), crocodile densities in the MNLC are at the lower end of the range. In spite of all the past and present habitat modifications, the MNLC still possesses fairly large areas of physically suitable crocodile breeding habitat, and this population still manages to reproduce successfully, despite the low numbers.

Webb *et al.* (1983) identified seven common aspects of *C. porosus* nest site vegetation, and according to these criteria, study areas 1 and 4 (dense vegetation, protected islets, slow water flow), and areas 2 and 5 (dry riverbanks) are expected to be prime breeding areas. While similar in habitat composition, these areas differ in their levels of human activity, and offer some insights into the possible effects of fishing and housing on the crocodile distribution within MNLC.

In areas 1 and 4, the understorey is sufficiently dense and at least 1.5 m high. *Phragmites karka* is abundant, the roots of *Annona glabra* can provide nest support, and there is plenty of direct sunlight. While these two areas consist of very similar habitat, area 1 had 2.3 times the density of brush piles. During this study, the entrance to area 1 was blocked by fishing nets almost 4 times more often than the entrance to area 4. Lower densities of both adults and juvenile crocodiles in area 1 can therefore likely be attributed to the more intensive fishing in this area.

Areas 2 and 5 consist of comparable habitat as well, but here the main human activities are not hunting or fishing, but spread of squatters' settlements and coconut plantations that tend to occupy all available dry ground. Permanent dry ground close to roads and main waterways is the most valuable asset in the whole region, and quickly attracts more settlers to both these areas. Currently, housing density is 4.8 times higher in area 5, and this difference is associated with a six and ten-fold decrease in observed adult and juvenile densities respectively. Area 2 is becoming increasingly populated, and cessation of crocodile breeding is likely, as has already happened in area 5, where the last nesting attempt was in 1992.

Area 3 is a section of Dandugam Oya River closest to the lagoon, and under significant tidal influence, with pronounced fluctuation in water level. Flooding can have a devastating effect on *C. porosus* eggs, killing up to 80% of all embryos in some regions. This area had a lower density of non-adults than would be expected from the observed density of adults, and 3 out of 4 nests were flooded during the course of the study. Therefore, although this area is remote and fishing is not intensive, it should be considered sub-optimal breeding habitat.

Unlike the mangrove forests elsewhere around the marsh complex, area 6 has not been destroyed, as it has no permanent and convenient road access (see Fig 1).

Flooding and lack of suitable nest material, such as grasses or herbs (Webb *et al.* 1977) can explain the scarcity of crocodile nests in the mangrove forest. In addition, small outrigger canoes used by fishermen are ideal for penetrating deep into the forest interior, allowing easy access to even the most remote sections. Consequently, crocodile nesting sites in this area are all well known and have been exploited for years. Fishermen destroyed both active nests in this area before the eggs hatched.

Conservation considerations

Although a conservation management plan for the MNLC has been proposed (Benthem and van Zon 1994), it does not include any special provisions for the remnant crocodile population. Incorporating a crocodile component into the general conservation plan for the area would strengthen the plan and assure that this genuine opportunity is not missed. Three key components would be: a) preservation and enhancement of critical breeding habitat, b) education, and c) close cooperation with local people through a comprehensive management plan (possibly including sustainable use) to ensure continued survival of this population.

Habitat preservation and enhancement

The data from this survey demonstrate a negative association between crocodile density and the intensity of human activities (fishing and housing), and indicate that some of the areas are being overexploited. Reducing juvenile and nest mortality should be the first step in securing the survival of this population. In addition, since female *C. porosus* spend the dry season in regions suitable for nest construction in the wet season, and selection of a freshwater site during the dry season may ultimately determine the location of their nest in the wet season (Webb *et al.* 1983), some presence of adult females in suitable breeding areas needs to be tolerated throughout the year. Both of these goals could be achieved by preventing further spread of squatters' settlements along Dandugam Oya River (western portion of area 2), and by regulating fishing activities in areas 1 and 4 (perhaps initially by prohibiting the practice of placing fishing nets across the entire width of canals, which would allow some free movement of adults in and out of this area at all times).

Education opportunities

The Muthurajawela Visitor Centre was set up in 1996,

Table 2: Observed active nests and crocodile sightings by size class in 6 study areas

	Size class					Nests		
Area	0-50	50-150	150-200	200-250	E.O.	Destroyed	Flooded	Successful
1	6	1	0	1	1	-	-	-
2	22	10	3	2	4	1	-	1
3	5	3	1	2	3	1	3	-
4	7	0	1	0	2	-	-	1
5	3	5	0	1	1	-	-	-
6	2	1	1	0	2	2	-	-
Total	45	20	6	6	13	4	3	2

Sizes are given as total length (cm),
E.O. indicate individuals who were positively identified as crocodiles, but submerged before their size was measured or visually estimated

and thousands of visitors (including 14,000 school children in 1997 alone) come every year for a scenic bird watching boat ride or stroll along the nature trails, guided by trained local residents. MNLC is close to Sri Lanka's capital city Colombo, with numerous hotels on the west shore, and most foreign tourists pass it on their way to and from the Katunayake International Airport. The Visitor Centre currently serves to educate tourists, visiting public and local fishermen alike.

Management considerations

It is ironic and possibly instructive that "in the countries where *C. porosus* is heavily but sustainably used, it is secure, but in the countries where it is completely but ineffectively protected, it may disappear" (Thorbjanarson 1992). Previous studies on crocodiles in Sri Lanka (Wikremasinge and Santiapillai 1999, Santiapillai and de Silva 2001) point out that in the absence of economic incentives at a local level, no amount of legislation will ensure the long-term survival of crocodiles outside the protected areas. Crocodilians, because of their high reproductive rates and valuable skin and meat, have considerable potential for sustainable use and management (Webb and Manolis 1993, Thorbjanarson 1992), and several successful sustainable use programmes have been implemented elsewhere (Bolton 1988, Jenkins 1994). Given its proximity to Colombo and other tourist hotspots, popularity, and the relatively poor agricultural potential of this area, MNLC might be the perfect launching site for the first project of this kind in Sri Lanka.

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ECOLOGICAL AND CONSERVATION STUDIES OF *ABUTILON RANADEI* WOODR. *ET* STAPF[1]

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Abutilon ranadei Woodr. *et* Stapf is one of the critically endangered plant species of the Western Ghats in India. It is endemic and restricted to four districts of Maharashtra State. Ecological and conservation studies revealed that the species is more restricted to moist deciduous forests in the Western Ghats. The plant suffers from a number of pests and diseases, and poor fruit set. It can easily be propagated by vegetative propagation through the air layering technique.

Key words: *Abutilon ranadei*, conservation, ecology, Western Ghats, threatened, critically endangered.

INTRODUCTION

The genus *Abutilon* Mill. belongs to Family Malvaceae and is represented by about 150 species. India is home to 12 species, 2 subspecies and 5 varieties (Paul 1993; Woodrow 1897). Of these, two species and four varieties are endemic to India. The genus is distributed mostly in the tropical or subtropical parts of the world. Many species are commercially important as they are highly ornamental.

Abutilon ranadei Woodr. *et* Stapf was first collected by N.B. Ranade, ex-keeper of the herbarium at the College of Science, Pune. Woodrow and Stapf (1894) described it as a new species and named it after Ranade. It is an endemic, known so far only from four districts of Maharashtra State. According to Cooke (1901), it is a rare plant. Due to its narrow range of distribution and extreme rarity, the species has been declared as endangered (Nayar and Sastry 1987; Venkanna and Das Das 2000) or even presumed extinct (Ahmedullah and Nayar 1986). However, it was recollected from its type locality after a lapse of almost 95 years (Mistry and Almeida 1989; Almeida 1996; Walter and Gillett 1997). Since then, the species has been collected from six new locations in Pune, Kolhapur and Satara districts (Table 1).

Abutilon ranadei is one of the most critically endangered plants of India (Mishra and Singh 2001), on the verge of extinction. Its survival in its natural habitat is further complicated by habitat fragmentation and habitat loss. It is a priority species for research and conservation. The present study was taken up with a view to understand the autecology and conservation related aspects of the species with special reference to wild and cultivated plant populations.

METHODOLOGY

The study was conducted between June 1997 and March 2002. The study area comprised mainly of three localities - Torna, Shilim and Amboli. The authors made regular field trips in different seasons to different localities and studied various ecological aspects of wild populations. Information on the phenology, association, pollinators, and seed setting were collected during field surveys. Simultaneously, aspects related to conservation, such as propagation techniques, cultivation practices, pests and diseases were also studied for wild and cultivated plants/ populations.

Habitat specificity: According to Blatter, the species is found only in Konkan. However, all the reported localities of the species, including the type locality, are from the southern Western Ghats in *madhya* (= central) Maharashtra (Almeida and Almeida 1989).

Geography: The species is distributed between 19°-16.4° N and 72° 6'-74° E; that is, between Shilim on the northwest of Pune to Amba Ghat near Kolhapur, covering an area of *c.* 500 sq. km (Fig. 1). The area of occupation is below 12 sq. km.

Geology & soils: Structurally, the natural locations of the species are a part of the Deccan trap, and the geological formations are of basaltic origin, with an abundance of silica, alumina and iron oxides. The soils are brownish to reddish in colour, poor in nutrients and slightly acidic (pH 5.5-6.5).

Vegetation, altitude & rainfall: The species is found at the edges of moist deciduous forests, on gentle hill slopes between 600-1,000 m above msl. All these regions receive high rainfall from the southwest monsoon. Annual rainfall

Table 1: *Abutilon ranadei* Woodr. *et* Stapf. – Ecology and Distribution

Locality	District	Forest type & Association	Number of individuals	Reference
Amba Ghat	Kolhapur	Mixed deciduous	Few	Woodrow (1894)
		Moist deciduous	7	*Mistry & Almeida (1989)
		—	19	*Diwakar & Moorthy (2001)
Radhanagari		—	—	Yadav & Sardesai (2002)
Vasota Fort	Satara	Moist deciduous *Carvia callosa* (Nees) Bremek.	50	Bachulkar & Yadav (1997)
Amboli	Sindhudurg	Moist deciduous *Carvia callosa* (Nees) Bremek. *Barleria* spp.	7	**Tetali (1998)
Shilim	Pune (Mulshi)	Moist deciduous *Carvia callosa* (Nees) Bremek. *Terminalia elliptica* Willd. *Kydia calycina* Roxb. *Xantolis tomentosa* (Roxb.) Raf.	250	Punekar *et al.* (2001)
		Sterculia guttata Roxb. ex Dc.	280	Lakshminarasimhan, Diwakar & Prasanna (2001)
Torna	Pune (Velhe)	Moist deciduous	175	*Punekar *et al.* (2000)
		Carvia callosa (Nees) Bremek.	40	**Tetali & Thopte (2000)
		Ziziphus rugosa Lam. *Woodfordia fruticosa* (L.) Kurz. *Atalantia racemosa* Wight	140	*Lakshminarasimhan, Diwakar & Prasanna (2001)
Rajgad	Pune (Velhe)	Moist deciduous *Carvia callosa* (Nees) Bremek. *Vernonia divergens* (Roxb.) Edgew. *Rhinacanthus nasuta* (L.) Kurz. *Pentanema cerunum* (Dalz.) Ling. *Vigna khandalensis* (Sant.) Raghavan & Wadhwa	45	*Datar Mandar & C.R. Jadhav (2002)

* Personal communication, unpublished data, year of observation is given in parenthesis.
** Senior authors field survey observations, noted from field note book.

ranges between 4,000 mm to 7,000 mm.

Population size: The natural distribution is highly fragmented and the plant is not found in abundance anywhere. Population size (mature individuals) at different localities ranged between 7-280. Some of these localities are adjacent to private land. The natural habitat suffers a variety of depredations due to human interference.

Association: *A. ranadei* populations were discovered in moist deciduous forests. In almost all localities, they grew among thickets of *Carvia callosa* Bremek.

Description & Ecology: Undershrub, or large shrub, up to 2.5 m tall. Plant parts densely and minutely stellately hairy. Leaves ovate to round-ovate, apex acute to acuminate, base cordate, margin crenate to dentate.

Flowering: *A. ranadei* is a fast growing plant. Flowering normally commences in plants about 7-9 months old. Flowers bisexual. Calyx campanulate. Lobes 2-2.7 cm long, connate in the middle, stellate-hairy and glandular. Corolla campanulate with pale purple prominent veins on orange-yellow petals, tips prominently yellow. Petals 1 to 2 times longer than the calyx. Staminal column 20-35 mm long, glabrous, reddish, filaments white, with reddish base, 3-5 mm long. Upper part of the filament sparsely covered with dumbbell shaped glandular hairs. Anther kidney-shaped, initially green, turns dark rose at maturity and brownish violet at dehiscence. Carpels 5. Styles as many as carpels, up to 7 mm long, sparsely hairy (Fig. 2).

Floral biology: Flowering begins in the second week of November and continues till the end of March. Flowers axillary, solitary, pedicels up to 8 cm long, jointed in the upper half. Opening of flowers begins in the afternoon. Maximum flowers open between 12-15 hours (68%). Individual flowers have 3-5 days for pollination. The process of floral development, from opening of flower to pollination, takes place in four stages (Fig. 3).

Paint brush stage (Stage 1): During this stage, floral parts are enclosed in a swollen calyx tube, which is green and glandular. A few bearded white filaments with immature white anthers protrude conspicuously among the yellow tips of the petals. Petals are almost equal or slightly longer than the calyx tube. The flower bud appears like the head of a paintbrush.

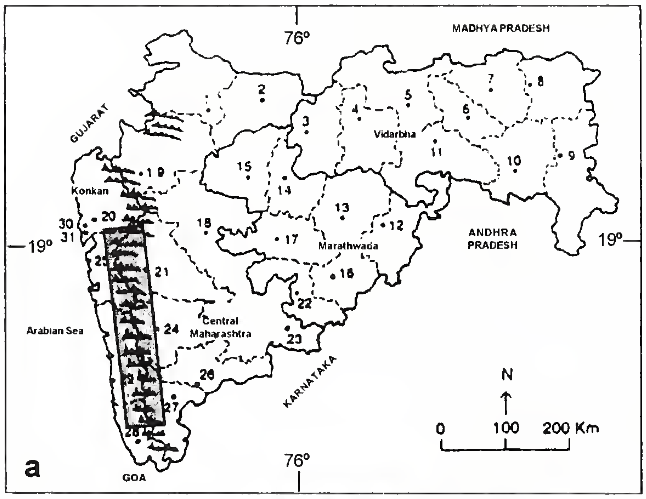
Trumpet stage (Stage 2): At this stage, a number of modifications of floral parts occur, to attract pollinators. It begins with the enlargement of petals and staminal tube. Petals grow longer and wide at the base (length: from 2.5 cm to 3-6 cm; wide: up to 2.5 cm). Two thirds of the proximal end of petals turns light purple, while the distal end turns orange yellow. Whitish veins are more prominent. The spacing between two petals widens. From the almost contorted and overlapping stage, the distance between petals increases to about 2.5 cm towards the distal end. This facilitates a wide open corolla mouth. The yellow region of the petals slowly turns backwards and the corolla resembles a trumpet. Simultaneously, the staminal column with anthers also increases in length (from 2 to 4.5 cm long). The column becomes shining, turns dark purple or reddish-brown. The filaments increase in length from 0.3 cm to 0.5 cm. They are positioned perpendicularly, and hairs on the filaments are more conspicuous.

The white anthers turn reddish-brown or brick coloured. Dehiscence occurs during daytime with increasing temperatures. Anthesis does not take place on the same day, but in phases for about two days. Pollen yellow, spherical, size 55-57 μ diameter, single colpate, echinate, aperture 5-8 μ wide (According to Nair 1962, average size 76 μ; range 74-77 μ). Exine 4.2 μ thick. Basal cushion of spinules not formed (Fig. 4). Styles 5, distinct, 0.5 cm at the time of anther dehiscence. Stigma capitate.

Pollination stage (Stage 3): During this stage, the glandular hairs on the calyx tube emit a strong odour, like curry leaves. The secretion of nectar follows this. Nectaries are located at the base of the petals. The staminal tube twists slightly during or after anther dehiscence. Style length increases on the second day from 0.5 cm to almost 1.5 cm. Styles turn backward into an inverted 'C' shape. Odour from the calyx tube, colour of the corolla and nectar attracts insect visitors belongs to the families. The insect visitors were mostly nectarivorous.

The floral biology and the timing of anthesis indicate that the species prefers cross-pollination. Flowering may not necessarily result in fruit formation.

Observations to identify pollinators were made consecutively for three years. Night observations had to be abandoned due to practical difficulties (especially inaccessibility) in working in natural habitat. Observations were carried out from dawn to dusk. The floral nectar fallen



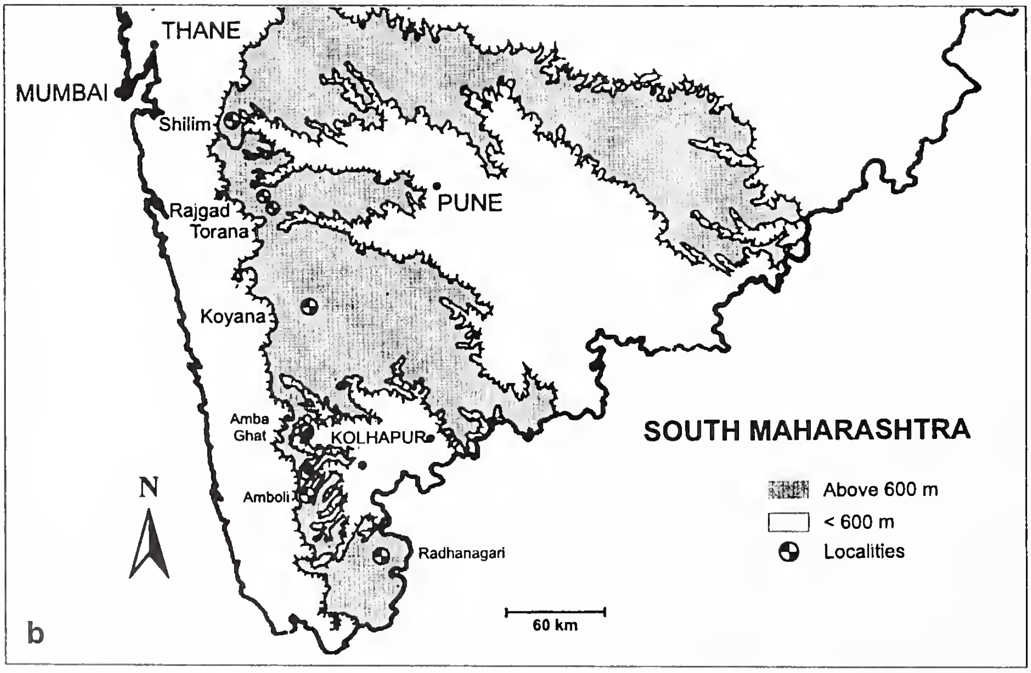


Fig. 1: *Abutilon ranadei* Woodr. *et* Stapf,

a. Distribution map, Maharashtra,

b. Locality map, south Maharashtra

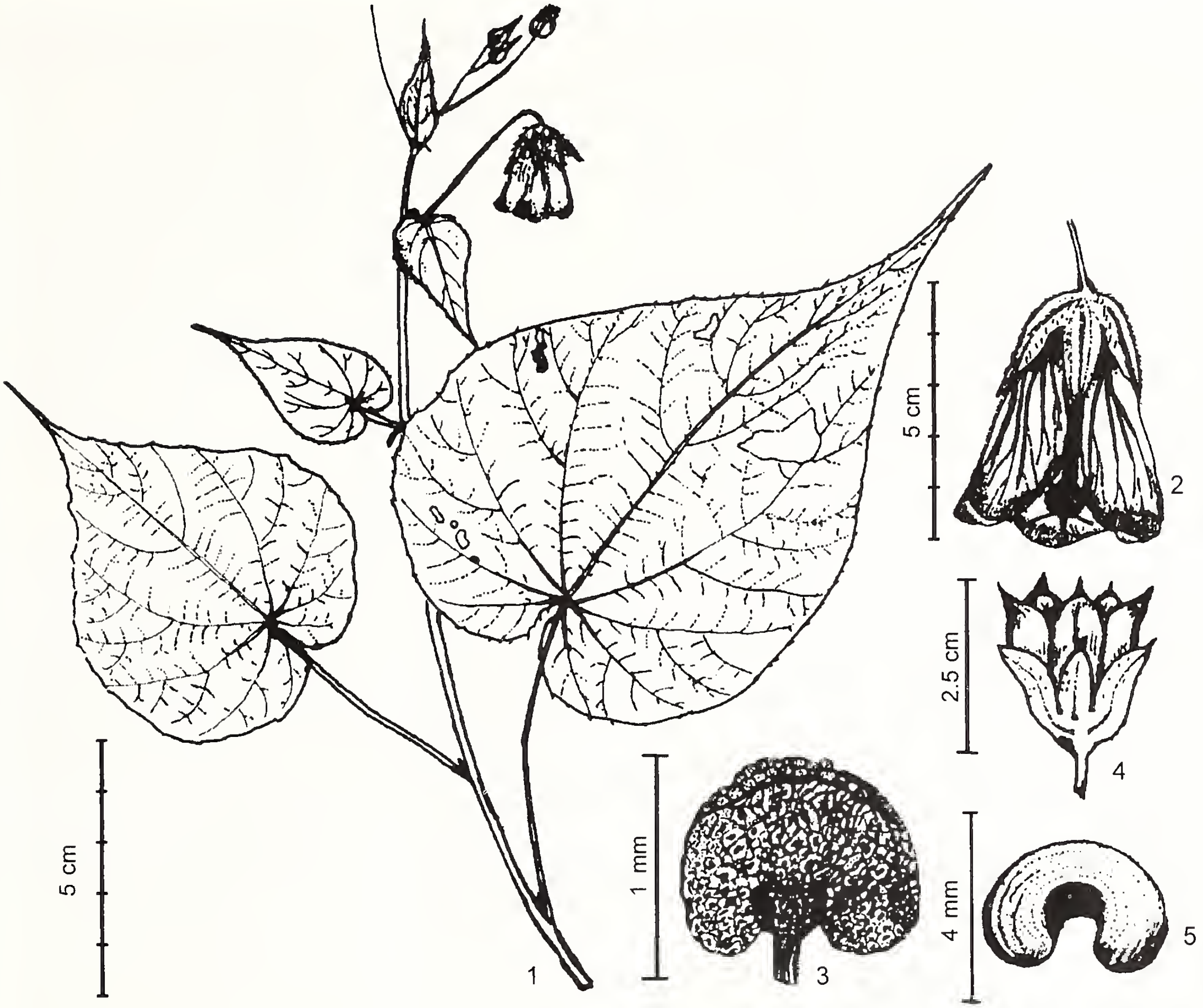


Fig. 2: *Abutilon ranadei* Woodr. *et* Stapf, 1. Habit, 2. Flower, 3. Anther, 4. Fruit, 5. Seed

on leaves and other vegetative parts was seen to attract flies and other insects. Despite thorough observations, no pollinator was seen during the first two years of our study. This, and other factors such as trumpet shaped flowers, odoriferous calyx, colours of the corolla, and secretion of nectar at the base of petals indicate that moths or other nectar-drinking insects might be the true pollinators. No conclusions, however, could be made, due to lack of evidence. Other factors, such as small population size and the resultant scarcity of forage plants (pollen) or nectar may have contributed to the absence of pollinators. Curiously, in the third year, at the end of the flowering season we noticed insects visiting the flowers. A detailed record of the insects, their flower visiting behaviour and food preferences were recorded. The peak period of flowering was only for two days. The insects stopped visiting the plants, as the number of flowers per plant drastically decreased. During the entire study we observed two insect species visiting flowers. Among the insect visitors, Honeybees (*Apis mellifera*), the occasional visitors, may not contribute in pollination. They were seen feeding only on pollen. Bees generally ignore or cannot recognize the flowers of *A. ranadei*. A frequent visitor was *Anthophorus zonata* (Family Anthophoridae, Order Hymenoptera), a fast flying insect and mostly a nectar feeder. The size of the insect and staminal column length indicates that it may not be a true pollinator, but an optional pollinator. A detailed record of the behaviour of *Anthophorus zonata*, flower visiting pattern and food preference were recorded (for two days only). The results showed a positive relation between number of visits and average time spent on each flower from morning to noon. Number of visits and average time spent collecting nectar dropped from 12 a.m. to 2 p.m. In the later part of the day, the number of visits gradually reduced and the average time spent for collecting nectar greatly

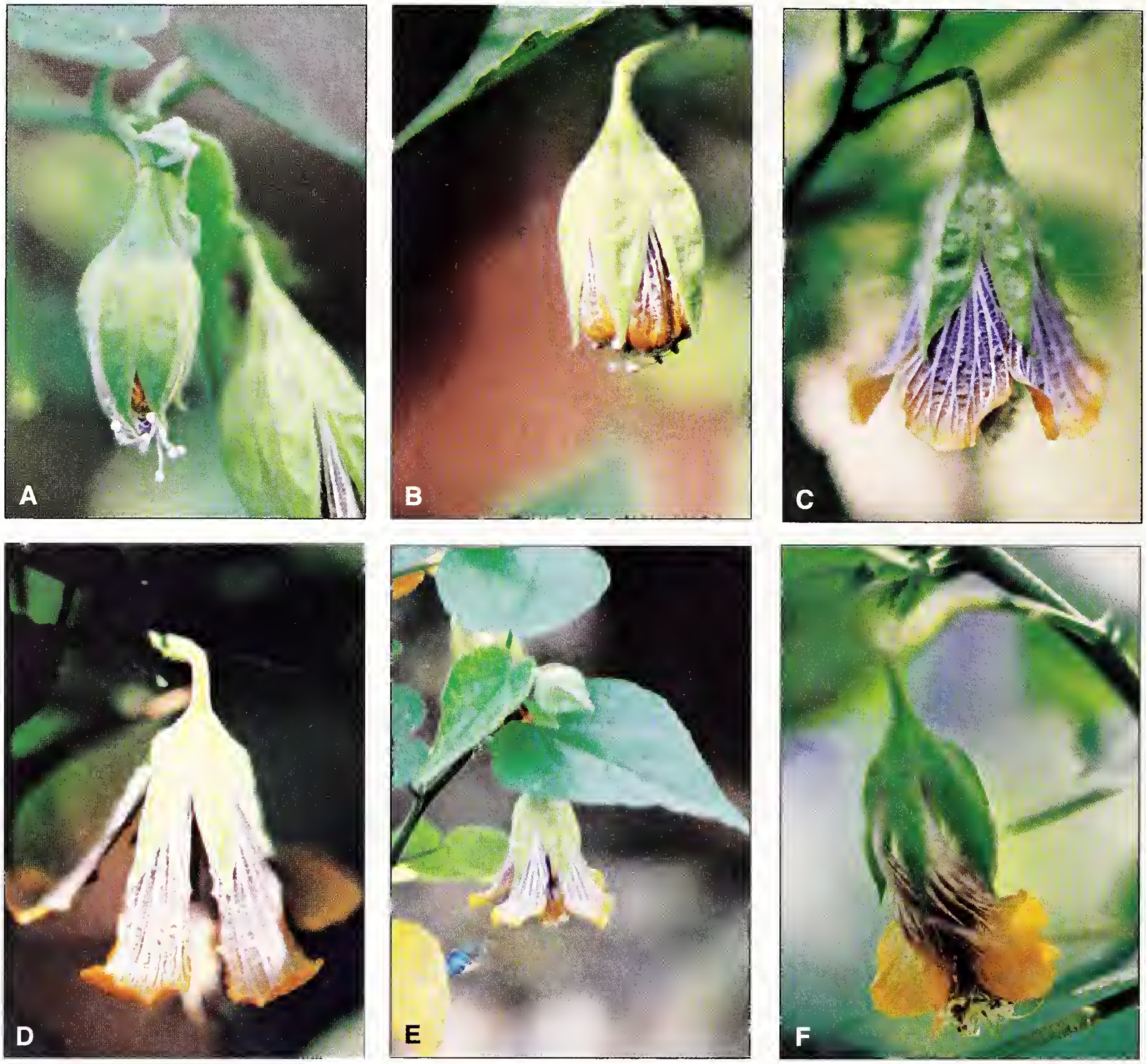


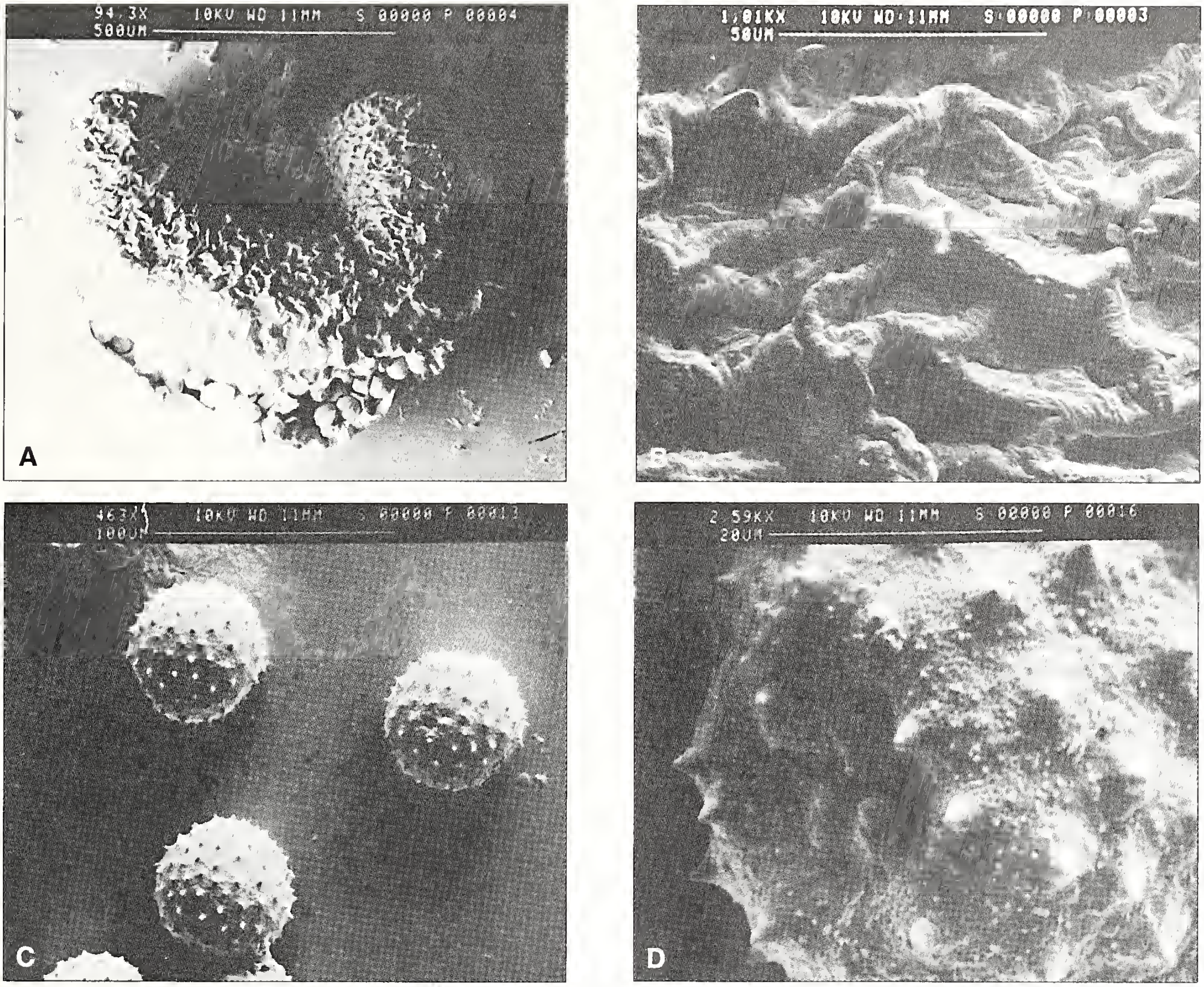
Fig. 3: *Abutilon ranadei* Woodr. *et* Stapf, Floral biology: A & B. Paintbrush stage, C & D. Trumpet stage, E. Pollination stage, F. Contorted corolla stage

increased (Fig. 5). On the third day, the number of insects visiting flowers declined sharply. We observed a positive correlation between insects visiting flowers and pod formation. Further studies are also required to identify the pollinators, and minimum number of mature plants required to attract pollinators. It is not clear whether it is the pollen or the nectar or both, that mainly attract pollinators.

Flowering may not necessarily result in fruit formation. Gregarious flowering was never noticed. On any given day during the flowering season, about 2-12 open flowers are observed on each plant. The total number of flowers set in a season by healthy and mature individuals range between 20-340.

Contorted corolla stage (Stage-4): In this stage, the corolla becomes twisted, mostly on the fourth or fifth day. The corolla shrinks slowly before it falls off. The corolla of the pollinated flowers contorts around the staminal column and blocks the entry of insects or other visitors.

Field observations showed that 60-90% of the flowers fall off without any sign of fruit formation. The calyx tube turns yellow and becomes detached from the pedicel after the corolla tube is shed. The flowers offer pollen as well as nectar in large quantities. Anther dehiscence does not take place instantly. Anthers of some flowers dehisce in more than one phase, preferably in two phases. Location of nectar and flowering time tentatively indicates that flowers may be


94.3X 10KV WD 11MM S 00000 P 00004
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50UM
B
463X 10KV WD 11MM S 00000 P 00013
100UM
C
2.59KX 10KV WD 11MM S 00000 P 00016
20UM
D

Fig. 4: *Abutilon ranadei* Woodr. *et* Stapf, Scanning Electron Microscope photographs of anther and pollen: A. Single anther, B. Monothecous anther, C. Echinate pollen, D. Pore

pollinated by nectar feeding insects, probably moths.

Seed set: Only 4-20% flowers develop into mature fruit. Fruit a schizocarp, seeds 2-3 per mericarp, brownish-black, kidney-shaped. Fruit formation begins in December and continues till the end of April. Number of fruits per plant range from almost nil to 27.

Seed germination: Depending upon the location, percentage of germination varied from 2%-35% (Table 2).

Propagation: *A. ranadei* can be propagated by seed as well as vegetative propagation.

a) Seed: Germination tests were conducted under nursery conditions. Seeds were sown in net pots and plastic trays. The percentage of aborted seed in this method is very high as the seeds are generally shriveled, small and nonviable. The seeds germinate very slowly, taking a minimum of 20 and a maximum of 30 days to germinate. Net pots are ideal for sowing. Germination takes up to three months in net pots. Seedlings prefer shade (under 90% shade nets). Details of the seed characteristics are presented in Table 2.

b) Vegetative: Poor fruit set and high percentage of non-viable seeds led to the trial of various vegetative propagation techniques at our research farm. Air layering was found to be the most successful method of vegetative propagation. In this method, a girdle was made on a branch not less than 5 mm thick, at about 20-30 cm from the tip. About

Table 2: Seed characteristics of *Abutilon ranadei*

Character	Range	Mean
Number of seeds/ pod	3-15	5.4
Seed weight	0.014 – 0.020 mg	0.016 mg
Seed length	0.384 - 0.520 cm	0.45 cm
Seed diameter	0.353 - 0.464 cm	0.434 cm

- Number of pods studied – 20; Number of seeds studied: 100.

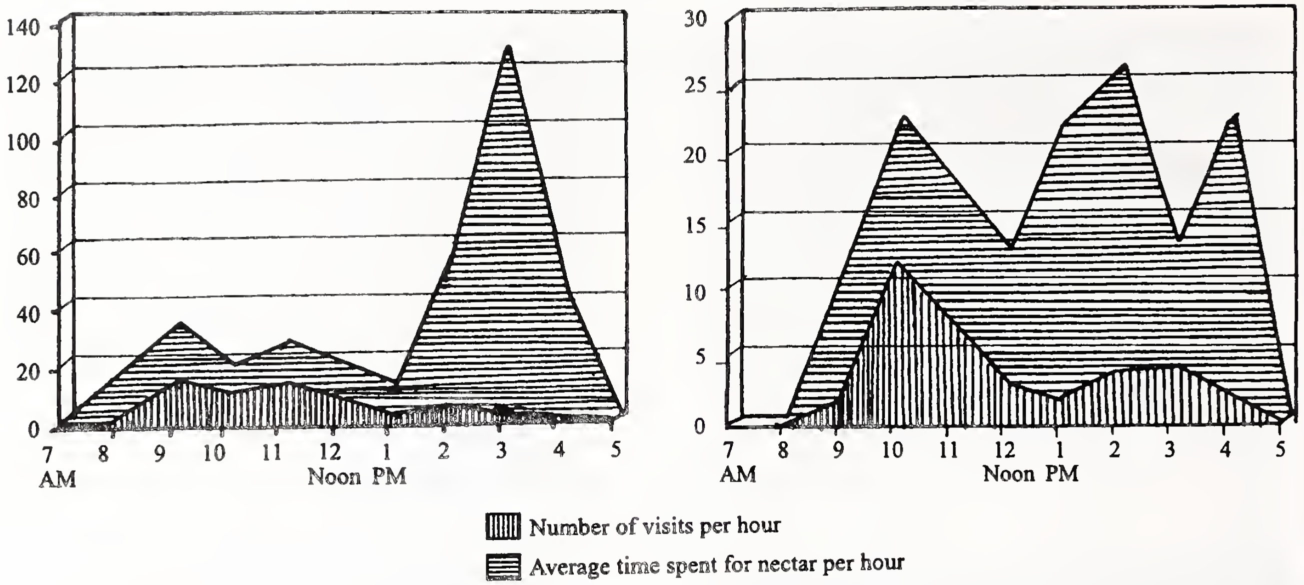

Fig. 5: Flower visiting behaviour of *Anthophorous zonata*

3-5 cm strip of bark was carefully removed (circular cut) without damaging the other parts. The phloem and cambium was completely removed by scraping with a blade to prevent the healing process. The scraped part was washed with Indole-3-butyric acid (IBA 4,000 ppm) for 5 minutes, the area covered with moist sphagnum moss and tied with a polythene sheet to keep the moss in place. Initiation of rooting was visible after two weeks. Rooting takes place within 21 days. The layers were ready for transplant within 45-50 days.

Cultural practices: The plant prefers slightly acidic soil and responds well to organic manure. Good growth is obtained in the following mentioned substratum.

Soil media: Red lateritic soil – 2.5 parts; Vermi compost – 1 part; Sterameal [7(N)-10(P)-5 (K)] – 0.5 part

For better growth, an additional 100 gm vermi compost + 100 gm sterameal per plant is required every three months.

Table 3: Leaf analysis (Macro & Micro nutrients) results of *Abutilon ranadei*

Parameter		Test value
Nitrogen (N)	-	3.25%
Phosphorus (P)	-	0.60%
Potassium (K)	-	2.06%
Calcium (Ca)	-	5%
Magnesium (Mg)	-	0.93%
Sulphur (S)	-	0.26%
Iron (Fe)	-	590 ppm
Manganese (Mn)	-	40 ppm
Zinc (Zn)	-	116 ppm
Copper (Cu)	-	22 ppm
Molybdenum (Mo)	-	<1 ppm
Boron (B)	-	51 ppm
Sodium (Na)	-	1984 ppm

Leaf analysis for various elements was carried out to understand the problem of flower fall after withering. The test values of the tissue samples showed high concentrations of Nitrogen and Potash, and deficiency of Phosphorus. Among the micronutrients, Sodium and Iron were present in significant amounts. The details of the leaf analysis are given in Table 3.

Spacing: 1 m x 1 m.

Watering: The plant requires good, regular watering. However, it cannot withstand water logging.

Light: *A. ranadei* is a light loving plant. It performs better under partially shaded conditions (The seedlings prefer 90% shade, while mature plants do well under 40% shade).

Pests & Diseases:

1. ***Tetranychus cinnabarinus* (Tropical Red Spider Mite)**

Family: Tetranychidae

Description: An oval shaped mite. Tiny, red or greenish with four pairs of legs (Fig. 6a). Polyphagous, common, serious pest of greenhouse plants and other cultivated crops.

Feeding habits: External feeder. All stages of insects feed on the lower side of the leaf surface.

Damage: Scarification, leaf silvering and appearance of yellow patches.

Control: Biological: *Phytoseilus riegeli* (predaceous mite).

Chemical: 1) Foliar spray of Dimethoate (0.5 ml/litre), 2) Carbaryl (2 ml/litre) + Neemarin (3 ml/litre), 3) Sulphur (3 gm/litre), 4) Kelthane (2 ml/litre).

2. ***Ferrisia virgata* (Ckll.) (Striped Mealy bug)**

Family: Pseudococcidae

Description: An elliptic shaped mealy bug with a pair

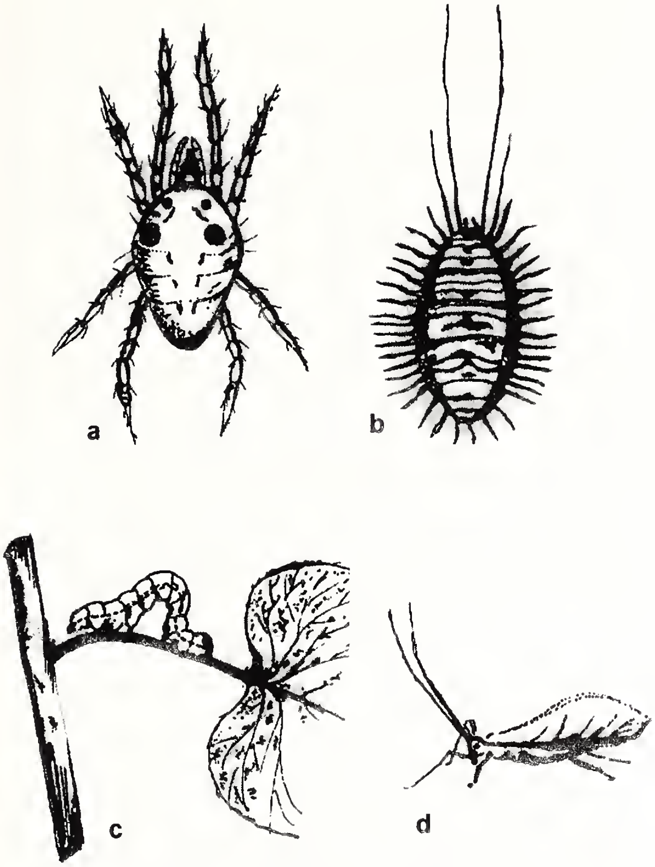

Fig. 6: Pests of *Abutilon ranadei* Woodr. *et* Stapf,

a. Tropical Red Spider Mite (*Tetranychus cinnabarinus*),
b. Striped Mealy Bug (*Ferrisia virgata*),
c. Cabbage Semi-looper (*Trichoplusia ni*),
d. Aphids (Family Homoptera)

of conspicuous longitudinal submedian dark stripes, pronounced long tail and long glassy wax threads (Fig. 6b).

Feeding habits: The most serious polyphagous pest. Sucking type, feeds on tender parts and leaves.

Damage: Wilting, infestation by sooty moulds, growth retardation.

Control: Biological: *Cryptoleumus monterouzuni* (6 per 100 sq. m)

Chemical: 1) Malathion (1 ml/litre) + Fish oil resin soap, Azinphos-methyl (2 ml/litre).

3. *Trichoplusia ni* (Hb.) (Cabbage Semi-looper)

Family: Noctuidae

Description: Green with a thin, white lateral line, and two white lines along the middle of the back. There are two pairs of prolegs (Fig. 6c).

Feeding habits: Larva feeds on young leaves. Active at low temperatures, makes irregular holes in the leaf.

Damage: Irregular holes in the leaf lamina.

Control: Biological: 1) *Bacillus thuringiensis*, 2) *Trichogramma* (parasitoid eggs 2000-3000 per 100 sq. m)

Mechanical: Ultraviolet light traps.

Chemical: Carbaryl (2 ml/litre)

4. Unidentified (Aphids)

Order: Homoptera, Family: Aphididae

Description: A small soft-bodied, sluggish insect, with piercing and sucking mouth parts (Fig. 6d).

Feeding habits: Usually attacks tender parts. Feeds on the lower surface of the leaves.

Damage: Leaf curling, infection with sooty mould, presence of ants.

Control: Biological: 1) Ladybird (Coccinellidae), 2) *Crysoperta carnae* (adults 400 per 100 sq. m), 3) Hymenopterous parasites.

Chemical: 1) Soap water, 2) A number of systemic insecticides (Permethrin, Pirimicarb).

5. *Chrysomphalus aonidum* (L.)
(Florida Red scale or Purple scale)

Family: Diaspididae

Description: Adult female is purplish and circular, with a reddish-brown boss or nipple in the centre.

Feeding habits: Feeds on leaves, young shoots and twigs.

Damage: Saliva is toxic, causing necrosis.

Control: Biological control: *Chilochorus nigritus*

Chemical: 1) Carbaryl (3%), 2) Parathion (0.5%), 3) Malathion with white oil

6. Unidentified Leafminer

(Microlepidoptera)

Description: Minor pest. Tunnel leaf mine with no central line of faecal pellets.

Feeding habits: Attacks during rainy season.

Damage: Leaf tunnels. Destroys the photosynthetic structure.

Control: Chemical: 1) Triozophos (Hostathion 3 ml/litre), 2) Phosphamidon (1 ml/litre) + Fish resin oil soap (1 ml/litre)

7. Unidentified Snail

Phylum Mollusca

Description: Nil.

Feeding habits: Nocturnal feeders. Feed on young leaves, flower buds.

Damage: Minor damage. Young leaves are affected.

Control: Mechanical: Hand pick, Cabbage and Papaya – yellow leaves for trapping.

Chemical: 1) 2-4% salt water, 2) Lime treatment

DISCUSSION

All over the world, endemic plants are in double jeopardy. On the one hand, they are restricted to small pockets, being habitat specific. On the other, their habitat is being lost at an alarming rate, pushing them towards extinction. *A. ranadei* is a critically endangered plant. Urgent measures are required to conserve this plant in its natural habitat, mainly comprising the edges of moist deciduous forests of Western Ghats. It is often found growing among *Carvia callosa* (Karvi) thickets, which are prone to a variety of disturbances: being periodically cleared by the local communities for fuel wood, and to stake tomato plants.

High level of flower fall (60-90%) without fruit formation is a common problem in all the studied locations. Leaf analysis of the macro and micronutrients indicated the deficiency of phosphorus. However, extra support of phosphorus in cultivated conditions did not improve the condition of flower fall. Percentage of seed germination is also poor, only 2-35%.

The species also suffers from a variety of pests. About 7 pest species were recorded during the study, the most serious among them being the mealy bug.

The habitat of the species needs to be protected with the help of local communities. Further studies are required to identify the pollinators and to determine the minimum number of plants needed to attract pollinators

Abutilon ranadei is an ornamental plant and could be cultivated. Experimental trials are on at the Naoroji Godrej Centre for Plant Research to introduce this beautiful plant to horticulture and in artificial habitats.

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POPULATION STRUCTURE AND HABITAT COMPONENTS OF A NON-HUNTED ARGALI POPULATION IN THE EAST GOBI, MONGOLIA[1]

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Argali Sheep ground surveys and plant community studies were conducted on a 163.8 sq. km portion of a 607.4 sq. km study area in the eastern Gobi during 1993 and 1998. The Steppe plant community consisted of 27.1, 25.1, and 13.7 percent grasses/sedges, shrubs and forbs, respectively, including 20 species of forbs, 7 of grasses, and 4 of shrubs. A total of 162 Argali (15 ewes, 8 lambs, 99 rams and 40 unclassified ewes and lambs) were observed in 1993, and 171 (70 ewes, 28 lambs, 33 rams and 40 unclassified ewes and lambs) in 1998. Argali densities were 0.99 per sq. km in 1993 and 1.04 per sq. km in 1998, indicating a stable trend. The high ram numbers in larger size classes (>50%) and average age at natural death of 9 years (range 6-13) indicate that the rams survive to an old age. A ratio of 40 lambs : 100 ewes in 1998 indicate an increasing population. This Argali population is probably viable due to favourable forage conditions, curtailed illegal hunting, unfragmented habitats, and stable numbers.

Key words: Argali, Gobi Desert, habitats, Mongolia, monitoring, *Ovis ammon*, population trends, wild sheep

INTRODUCTION

Argali (*Ovis ammon*) wild sheep occur in temperate mountainous, steppe, and desert, undulating and rugged habitats of central Asia, including Mongolia (Valdez 1982, Geist 1991). Two subspecies of Argali occur within Mongolia, the Altai Argali (*O.a. ammon*) of western Mongolia and the Gobi Argali (*O.a. darwini*) of the Gobi Desert in southern Mongolia. They are listed as rare by the Mongolian Ministry for Nature and Environment (MNEM 1997) and are on the United States Fish and Wildlife Service list of endangered and threatened wildlife and plants (USFWS 1997). In addition, they are listed as vulnerable and endangered by the IUCN (2000), and in Appendix II of CITES (USFWS 2001). Mongolia encompasses 1,656,000 sq. km, of which approximately 25% is potential Argali habitat (ASM 1990), but only about 61.5 sq. km are included in protected areas (MNEM 1997). Limited sport hunting by foreign hunters who currently pay up to $50,000 for a hunt has been permitted since 1968. The current Mongolian law on hunting established in 1995 and administered by the Mongolian Ministry for Nature and the Environment regulates the commercial use of wildlife. Hunting fees are an important source of foreign currency in a badly depressed economy (MNEM 1995).

Argali populations declined throughout Asia during the last Century (Harper 1945; Mallon 1985; Heptner *et al.* 1989; Fedosenko *et al.* 1995; Mallon *et al.* 1997; Reading *et al.* 1997), but specific population status and trend information, although a fundamental requirement for conservation (Wegge 1997), is lacking. In this paper, we document habitat conditions, population status and trend for a non-hunted Argali population in the eastern Gobi of Mongolia. This is the first such published study for Argali in Mongolia. Population trend data is essential for managing populations and for comparing with hunted populations.

STUDY AREA

The 607.4 sq. km study area is situated in the Ikh Nartiin region of the East Gobi Aimag (province) south of the village of Chayr (Fig. 1) in a steppe landscape characterised by undulating terrain and large rocky outcrops (Fig. 2). The study area is within the Ikh Nartiin Nature Reserve established in 1996 to protect the scenic landform (Myagmarsuren in Kenny *et al.* 2001). The entire study area is Argali habitat. Elevations range from about 1,220 to 1,300 m and average annual precipitation is about 200-250 cm (ASM 1990). The daily temperature is ≥ 10 °C for 110 to 130 days per year and the average annual daily temperature is about 2 °C (ASM 1990). January is the coldest, with temperatures of -40 °C or colder in contrast to > 38 °C during summer. Dry gullies or draws are dispersed throughout the area and the only permanent stream is situated in the northwestern portion. The land ownership is public and devoted to raising livestock on open range. There are few paved roads and motorised vehicles are infrequent. Domestic animals include cattle, sheep, goats, camels, and horses, with sheep predominating. Wolves (*Canis lupus*) are the only large predators present.

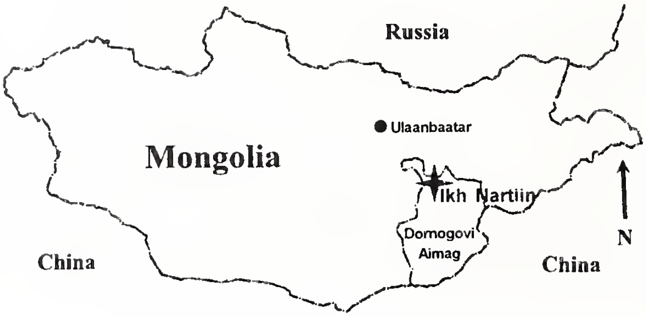

Fig.1: Location of the Ikh Nartiin study area in southeastern Mongolia

Steppe plant communities in Mongolia are complex (Hilbig 1995; Gunin *et al.* 1999). ASM (1990) described this portion of the eastern Gobi as steppe dominated by needle grasses (*Stipa klemenzii* and *Stipa krylovii*) and *Cleistogenes squarrosa*. In the study area, other grasses included fescues (*Festuca* spp.), and wheatgrasses (*Agropyron* spp.). A tall robust grass, *Achnatherum splendens* is dominant in gullies or draws. A variety of forbs including wild onion (*Allium* spp.), and shrubs such as sagebrushes (*Artemisia* spp.), caraganas (*Caragana* spp.), salt cedars (*Tamarix* spp.), junipers (*Juniperus* spp.), currants (*Ribes* spp.), and cherry (*Prunus* spp.), were common components in plant communities at Ikh Nartiin.

METHODS

Wild sheep were systematically surveyed in the study area on September 9-10, 1993 and October 8-9, 1998. Sheep surveys were conducted on foot from approximately the same observation points and along the same ridgeline travel routes during both years. Sheep were also observed from jeeps when travelling between observation points. Drop off points, base camp locations, and observation points were documented using GPS technology. Animals were observed with the aid of 8x and 10x binoculars and 10x - 45x spotting scopes. One observation group, consisting of 3 to 4 experienced observers, went into the field together each day to observe sheep. Censuses were conducted over a 2-day period because it allowed sufficient time to adequately cover the area and to minimize counting the same animal more than once. When the possibility existed that the same animals were observed more than once, only the first observation was recorded to minimize error. Location and altitude of sheep observation sites were recorded using GPS technology.

Observed Argali densities were determined by dividing the number of animals observed by the size of the survey area. Each sheep observed was classified into one of the following categories; adult ewe, lamb, or ram. Rams were classified into size classes based on horn length (Geist 1971; Fedosenko *et al.* 1995) as follows: Class I (1-2 years old), Class II (3-4 years old), Class III (5-6 years old) and Class IV (>6 years old). Cause of death of ram carcasses found in the field was determined by the remains. If most of the skeleton including the head and horns was present, death was assumed to be from natural causes. In a few cases, local herders directed us to the remains of Argali that had died during winter.

In 1998, the plant community at Ikh Nartiin was quantified by recording species composition, canopy coverage, and frequency of occurrence for plants along four 60 m long line transects using the method of Daubenmire (1959). English common names for plants are included when available, otherwise common names are omitted. On October 10, 1998 data from 20 quadrats (20 x 50 cm) were recorded along each of the 4 line transects (total 80 quadrats). Quadrats were placed at 3 m intervals along each transect line. Each plant species and form class within a quadrant was determined to be in 1 of 6 different percent cover classes: 1 = 0-5%, 2 = >5-25%, 3 = >25-50%, 4 = >50-75%, 5 = >75-95%, 6 = >95-100%. Percent cover was summarized by using the midpoint for each cover class recorded to determine the mean. Frequency of occurrence was determined based on the number of quadrats in which the species occurred. Transects were established at representative upland sites where Argali had recently been observed. Riparian vegetation associated with one perennial unnamed stream in the study area was described by developing a species list of the plants observed in the riparian zone.

RESULTS AND DISCUSSION

Vegetation Structure and Composition

The steppe plant community consisted of 27.1, 25.1, 13.7 percent grasses/sedges, shrubs, and forbs respectively (Table 1). Grasses/sedges, forbs, and litter or old plant material were the most frequently occurring vegetative classes. The most diverse vegetative class was forbs with 20 species followed by grasses and sedges with 7 species each and shrubs with 4 species. Total cover does not equal 100% because plant communities are composed of plants of varying heights, thus in reality the ground may be covered more than once due to a layering effect.

All plants observed were natives, many of which are palatable to a variety of wild and domestic ungulates (Bespalov 1951; Heptner *et al.* 1989; Bedunah and Miller 1995; Frisina and Gombosuren 2000). Because species composition varies by season, data in Table 1 most accurately depict species present late in the growing season. The third highest cover class (14.0%) and most frequently occurring class

(98.8%) was litter or old plant material.

Four species of grasses (*Koeleria muhdensis*, *Stipa krylovii*, *Achnatherum splendens* and *Cleistogenes squarrosa*) frequently occurred along or near stream banks and throughout the floodplain. *Carex durusicula*, a sedge, was also frequently observed. Small, scattered clumps of Siberian Elm (*Ulmus pumila*) were occasionally present in gullies. Three species of shrubs (*Armeniaca sibirica*, *Ephedra monosperma* and *Caragana leucophloea*) were observed. *Artemisia xerophytica*, *Allium polyrrhizum*, and *Convolvulus ammanii* were associated forbs. All plants observed within the riparian and associated flood plain were native to the area.

Table 1: Canopy coverage and frequency of taxa in the steppe plant community at Ikh Nartiin

Form Class and species	Canopy Cover (%)	Frequency of occurrence (%)
Grass/Sedges	27.10	96.25
Agropyron cristatum	0.69	10.00
Carex durusicula	0.19	7.50
Cleistogenes squarrosa	3.66	83.75
Koeleria glareosa	0.25	10.00
Koeleria gracilis	0.38	15.00
Koeleria muhdensis	6.03	32.50
Sitpa krylovii	13.82	85.00
Shrubs	25.14	30.00
Caragana leucophloea	3.28	22.50
Ephedra monosperma	0.06	2.50
Ephedra sinica	0.22	2.50
Unknown Shrub	0.47	2.50
Forbs	13.66	92.50
Allium polyrrhizum	2.41	23.75
Arenaria capillaris	0.13	5.00
Arenaria sibirica	0.88	5.00
Artemisia adamsii	0.03	1.25
Artemisia frigida	4.00	55.00
Artemisia klemenzii	0.41	10.00
Artemisia spp.	0.06	2.50
Asparagus dahuricus	0.41	10.00
Astragulus mongolicus	0.03	1.25
Astragulus spp.	0.10	5.00
Corispermum mongolicum	0.06	2.50
Corispermum orientalis	0.25	3.75
Dontostemon integrifolius	0.03	1.25
Heteropappus hispidus	0.10	3.75
Iris bungei	0.03	2.50
Orostachys spp.	0.03	1.25
Potentilla leucophylla	0.03	1.25
Rhamnus erythroxylon	1.11	2.50
Unknown Brassicaceae	1.00	40.00
Unknown Forb	1.01	3.75
Mosses & Lichens	1.10	21.25
Rock[a]	19.41	71.25
Bareground	42.19	97.50
Litter	14.01	98.75

[a] rock is a stone greater than 2.5 cm in circumference

Cover and frequency of occurrence for the physical characteristics of bareground and rock were measured (Table 1). Cover of bareground (42.2%) dominated, which is typical of arid plant communities. Rock (19.4%) was also an important cover class. Rock and bareground were present on the majority of plots. Plant cover in the Gobi region is typically sparse (Bespalov 1951).

Argali Population

Total sheep observed in 1993 and 1998 were 162 and 171 respectively, of which 122 were classified by sex or age in 1993 and 131 were classified in 1998 (Table 2). Forty sheep that were either ewes or lambs were observed in 1993 and 1998, but could not be differentiated and were thus not included in Table 2. However, they were included in calculating Argali density and in tabulating the number of rams observed in the population. Of the 99 rams observed in 1993, 52 were classified into age classes and all 33 rams observed in 1998 were classified into age classes. The observed ram age structure was 13 Class I, 7 Class II, 23 Class III, and 9 Class IV in 1993 and 1 Class I, 12 Class II, 2 Class III, and 18 Class IV in 1998.

Population Density

A population density of 0.99 Argali per sq. km was recorded in 1993 and 1.04 Argali per sq. km in 1998. These data indicate a stable trend in population density at Ikh Nartiin. Population densities observed in the eastern Gobi are similar to the 1.0-1.2 per sq. km for Marco Polo's Argali (*O.a. polii*) observed by Heptner *et al.* (1989) and the 1.3 per sq. km reported for Tibetan Argali (*O.a. hodgsoni*) by Jie and Sheng (1990) in China's Qinghai Province. Fedosenko *et al.* (1995) observed 2.5 Marco Polo's Argali per sq. km in Kirghizstan within a protected area with limited hunting. Reading *et al.* (1997) observed a much lower Argali density of about 0.019 per sq. km during an August 1994 aerial survey over 4,552.5 km of transects in Mongolia's south Gobi. However, they included large areas of unsuitable Argali habitat in their survey. In a synthesis of literature, published and unpublished, Reading *et al.* (1997) reported Argali densities from about 0.02 to 2.3 animals per sq. km in Central Asia.

Population Structure

In 1993, 39% of Argali observed were ewes and lambs as compared to 75% in 1998. The reason for this difference is unknown, but could be the result of there being fewer rams in the survey area during 1998. We also may have missed seeing some rams during the survey. The proportion of the

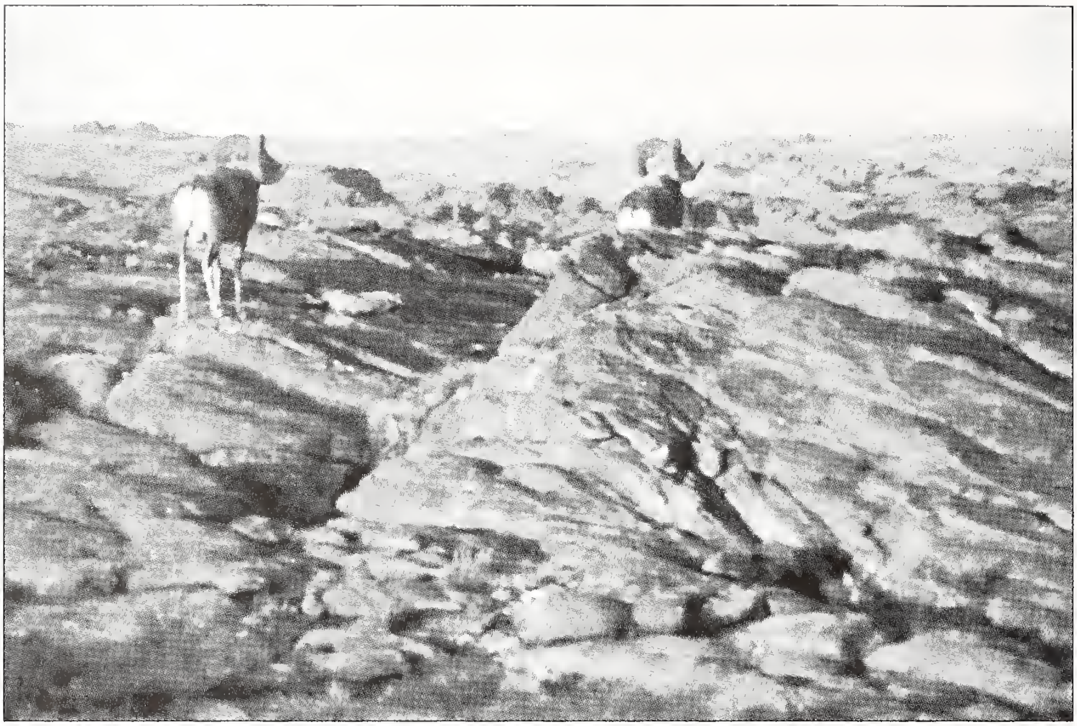

Fig. 2: The study area is typified by undulating terrain and large rock outcrops

population observed as ewes (53%) and lambs (21%) during 1998 is similar to that reported by Reading *et al.* (1997) for south Gobi in Mongolia. However, 12.7% of the animals included in Reading *et al.* (1997) were of undetermined sex, while our sample only included animals classified by sex and age.

In 1998, 25% of the Argali observed were rams compared to 61% in 1993, which is higher than the 14% reported by Reading *et al.* (1997) for a ground survey in south Gobi. For a lightly hunted Marco Polo's Argali population in Kirghizstan, Fedosenko *et al.* (1995) reported a population structure of 36% females, 15% lambs, 10% yearlings, and 38% males.

A ratio of 47.1 males : 100 females was observed in 1998. This is higher than the 26.9 males : 100 females reported by Reading *et al.* (1997), but lower than the 105 males : 100 females reported by Fedosenko *et al.* (1995) for Marco Polo's Argali in Kirghizstan and 59 males : 100 females reported by Schaller (1998) for Argali (*O. ammon*) in China's Xinjiang Province. A high ratio of males to females in the study area is indicative of an unhunted population.

Table 2: Population structure of Gobi Argali (*Ovis ammon*), classified by sex and age at Ikh Nartiin, Mongolia, 1993 and 1998

					Rams by Size Class				
Year	Total Class	Ewes	Lambs	Rams	I	II	III	IV	Uncl.
1993	122	15	8	99	13	7	23	9	47
1998	131	70	28	33	1	12	2	18	0

Rams

The proportion of rams observed by size class in 1993 was 25% Class I, 14% Class II, 44% Class III, and 17% Class IV and in 1998 size classes were 3% Class I, 36% Class II, 6% Class III, and 55% Class IV. A higher number of Class II and Class IV rams were observed in 1998 compared to 1993. A lower number of Class I and Class III rams were observed in 1998 than in 1993. These differences may reflect variation in recruitment and survival rates of individual age classes over 6 years. These differences may also be partially due to sampling biases because of the short census period of 2 field days. Fedosenko *et al.* (1995) observed a male population segment structure of 31, 33, 30 and 6 percent for Class I, II, III, and IV rams, respectively, in Kirghizstan, in a lightly hunted population.

The relatively high numbers of rams in the larger size Classes (III and IV) indicate that significant numbers of rams are surviving to maturity. Significant survival of rams to maturity is further evidenced by ages of rams found dead in the field. Horns of 17 rams found in the field dead from natural causes were aged by counting annual horn growth rings (Geist

1966). The mean age at time of death was 8 years old. Ages ranged from the youngest, a 3 year old to a 13 year old. Of the 17 rams found dead of natural causes, 14 were Class IV (>6 years) and their mean age at death was about 9 years. Age at death for Class IV rams ranged from 6 to 13 years, with 2 greater than 10 years old. Geist (1991) and Schaller (1998) estimated the average life span for mature Argali rams as about 9 years. Rams at Ikh Nartiin are surviving to a similar average life span, indicating favourable habitat conditions (Hoefs and Cowan 1979).

Ewes and Lambs

During 1998 surveys, 70 ewes and 28 lambs were observed at Ikh Nartiin, yielding a ratio of 40 lambs : 100 ewes. The ratio indicated a productive population. Lambs were about 5 months old and this ratio reflects the proportion surviving the first early critical time period (Geist 1971; Hoefs and Cowan 1979). High lamb production and vigorous lambs (Geist 1971) typify high-quality wild sheep populations. Reading *et al.* (1997) observed 36.9 lambs : 100 ewes during August 1994 ground surveys in south Gobi. During late summer surveys in the south Gobi in 1993, Valdez *et al.* (1995) observed 124 females and 54 lambs, yielding a ratio of 44 lambs : 100 ewes. Fedosenko *et al.* (1995) reported a ratio of 43 lambs : 100 ewes for Marco Polo's Argali population in Kirghizstan. In the eastern Pamir of Tajikistan, Fedosenko and Weinberg (2001) reported a ratio of 41 lambs : 100 ewes for Marco Polo's Argali during a fall survey. A ratio of 41 lambs : 100 ewes was reported by Schaller (1998) for Argali on the Tibetan steppe. Harris *et al.* (2001) observed approximately 60 lambs : 100 ewes during fall surveys for Argali in Gansu Province, China. The ewe : lamb ratio at Ikh Nartiin is similar to that reported for other areas and is typical of a growing or healthy population (Geist 1971).

Population Trend and Size

The observed population densities of 0.99 per sq. km for 1993 and 1.04 Argali per sq. km for 1998 indicate a stable population trend. During the 1993 and 1998 surveys, 163.8 sq. km or 27 percent of the total Ikh Nartiin Argali range was surveyed. A minimum population estimate was calculated by extrapolating the observed density to the remaining 443.6 sq. km or 73 percent of the Argali range. Multiplying the observed densities for 1993 and 1998 by the size of the Ikh Nartiin Argali range provided a minimum population estimate of 601 and 632 Argali for 1993 and 1998, respectively. This estimate assumes that all Argali within the survey area were observed, but it is likely that all argali within the survey area were not observed. Even aerial surveys underestimate population density (Pollock and Kendall 1987). When conducting fall surveys utilizing a helicopter, the most accurate census method, one can only expect to observe 20 to 50 percent of the population (Remington and Welsh 1989).

CONCLUSIONS AND RECOMMENDATIONS

The survey data indicate that the Argali population at Ikh Nartiin is probably viable for population and genetic processes (Soule 1987; Morrison *et al.*1998). Argali occur over hundreds of thousands of sq. km of open range without obstructions like fences, canals, paved roads, heavy traffic or natural barriers. In 1993, we observed 106 Argali about 80 km southwest of the study area (44° N, 108° E) near Mandahsum village, indicating a widespread, continuous distribution of Argalis, which could travel and interbreed over large-scale landscapes. Natural population control factors may be operating because, although unhunted, the population was relatively stable between 1993 and 1998. Productivity of ewes and lamb survival through the first critical time period is similar to that reported for several other Argali populations. The high proportion of rams observed in the larger size Classes (III and IV) and mean age of about 9 years for Class IV rams found dead of natural causes, indicated good survival and that poaching is not a significant cause of mortality. The human population density in the study area is low and firearms, especially those of high calibre, are probably limited. The observed ratio of 40 lambs : 100 ewes and relatively high proportion of rams surviving to older age classes are indicators of a healthy population.

Range conditions at Ikh Nartiin are in mid to late seral stage and forage production is adequate for wild and domestic ungulates inhabiting the area. This is evidenced by the abundance of the current year's plant growth still present on the steppe near the end of the growing season and survival of rams into the older age classes.

The relatively high proportion of residual vegetation, diversity of native plants, and plant species composition indicates that livestock grazing has been light or moderate in the study area and the Argali habitat is in mid to late seral stage. During September 1993 and October 1998, most of the current year's plant growth was still present on the steppe, also indicating livestock grazing had been light.

During 1993 and 1998, few cattle, sheep, and horses were observed on the Argali range. An increase in livestock numbers could degrade habitat quality. A long-term grazing strategy for domestic livestock emphasizing sustainability of soils and vegetation while providing for the habitat needs of wild animals and human society should be developed (Valdez *et al.* 1995)

Long-term monitoring of this population should continue. Also, a management plan should be implemented that ensures the viability of the Argali population by encouraging continued protection by local herders, and includes economic incentives not to increase domestic livestock numbers. Issuing at least one license annually for trophy hunting, which would not deleteriously impact the population, should be considered as a means for funding conservation efforts by the local authorities at Ikh Nartiin. Should a hunting program be implemented, studies should be conducted to determine any social, economic, and ecological impacts. Funding from hunting can provide incentive to improve management and protection of wildlife in Mongolia (Valdez *et al.* 1995). Population parameters for this unhunted Argali population may serve as a management reference for comparison with hunted populations.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF THE BOMBAY NATURAL HISTORY SOCIETY – 40. FAMILY: FRINGILLIDAE: FINCHES[1]

Saraswathy Unnithan[2]

(Contd from *JBNHS 98(3)*: 347-354)

This part deals with 747 specimens belonging to 62 species and subspecies, up to Synopsis No. 2040 in the HANDBOOK (Vol. 10, p. 202) and 14 extralimitals. We do not have specimens for 4 species and 11 subspecies in our Collection.

1979 ***Fringilla coelebs coelebs*** Linnaeus (Europa = Sweden). Chaffinch 3: 163.

29: 8 males, 19 females, 2 unsexed.

1 Fahama, R. Tigris, 2 Sulaimaniya, 6 Hawiplain, Samara, 1 Amara, 1 Bagdad, Iraq; 1 Dohuk, Kurdistan; 2 Bagh Rezi, 1 Engeli, 5 Meshed, 2 Shiraz, 1 Pir-i-Bani 9 m.s. of Shiraz, 2 Shustar, S. Persia (Iran) 1 Persian Gulf, 3 Dattakhel, Waziristan, NWFP.

Most of the specimens were collected between 1917 and 1927. They cannot be confused with any other species due to a distinct greenish rump and a pair of pure white wing bars.

Measurements on p. 361.

1980 ***Fringilla montifringilla*** Linnaeus (Europa = Sweden). Brambling 3: 164.

13: 4 males, 8 females, 1 unsexed

4 Mosul, Iraq; 1 Parachinar, NWFP; 6 Chitral Drosh; 2 Simla, NWH.

The Chitral specimens were collected in 1903, Mosul in 1923, Simla specimens in 1924 and 1925. They are distinct and easily separable from *F. coelebs* due to their white rump, rufous mixed wing bars, feathers at the back and head with rufous edges, giving a scaly and mottled appearance to the back and head respectively.

Measurements on p. 361.

1981 ***Coccothraustes c. humii*** Sharpe (Attock, N.W. Punjab). Hawfinch 3: 100.

7: 5 males, 2 females.

2 Chitral, 3 Chhoi, near Campbellpur, 1 Jhalor, 1 Campbellpur, W. Punjab.

Bird with a massive bill, a narrow black border all around the base extending to a black patch on the throat. Very peculiar purple - black sinuous shaped tips to the secondaries. Sexes are separate, unlike the record in the HANDBOOK. The head of the male is cinnamon brown with a broad ashy collar on hind neck. In the female, the head is ashy and hence the collar is not distinct. The back of the male is cinnamon brown; rump, breast and flanks tawny brown, while those of the female are ashy brown.

Measurements on p. 361.

EL ***Coccothraustes c. japonicus*** Temminck *et* Schlegel (Japan) Hawfinch

8: 3 males 5 females

6 Temple of Heaven, 1 Peking, 1 Sutto

Measurements on p. 361.

1982 ***Mycerobas icterioides*** (Vigors) (Himalayan Mountains = Simla-Almora area). Black-and-Yellow Grosbeak 3: 102.

29: 19 males, 9 females, 1 unsexed.

2 Chitral Drosh, 1 Chitral utzun, 1 Pingal, Badrawar, 1 Kashmir; 1 Naggar Kulla, 1 Dharmsala, 3 Dalhousie, 1 Muree, Punjab; 6 Kanain. 4 Narkanda, Kumarsain, Simla, 5 Koti State, 3 Simla Hill NWH.

Both the male and the female are distinct and easily separated from *M. affinis*, unlike the record in the HANDBOOK. The males have sooty black head, throat, wings and tail, whereas in *affinis* it is replaced by deep glossy black colour. The collar and rump are yellow, in *affinis* the collar and posterior rump are orange rufous.

Females of *icterioides* have light greyish-brown head, throat, breast and mantle, and light peach coloured rump and belly. The central pair of rectrices are greyish-brown with dark brownish-black rachis. Females of *affinis* have dark grey head, rest of upper parts olive green, throat grey and rest of under parts olive yellow, all rectrices are similar, brownish-black.

Measurements on p. 361.

1983 ***Mycerobas affinis*** (Blyth) (Alpine Punjab, restricted to Hazara by Whistler). Collared Grosbeak 3: 103.

2: 1 male, 1 female

Both the specimens are from Dakuri, Punjab.

They were registered and kept as *M. icterioides*. The

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MEASUREMENTS PART 40

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
1979 *Fringilla coelebs coelebs*				
Males: 8	80-89 av. 85.1	11.7-12.5 av. 11.9	17.1-18.5 av. 18.1	59-66 av. 62.2
	(IH 89-92			63-68)
Females: 19	81-87	11-12.4	17-18.4	59-65
1980 *Fringilla montifringilla*				
Males: 4	89-94 av. 91.2	11.7-12.8 av. 12.1	19-20 av. 19.5	60-66 av. 63.2
	(IH MF 89-94	12-13	18-19	63-66)
Females: 8	86-91 av. 88.3	11.5-13.2 av. 12.4	19-19.5 av. 19.3	57-63 av. 59.1
1981 *Coccothraustes coccothraustes humii*				
Males: 5	98-105 av. 102	19.7-21.2 av. 20.6	20-21.8 av. 21.1	60-65 62.8
	(IH 101-106	from skull 22-24	20-22	60-65)
Females: 2	98, 101	18.5, 20	21, 21.2	59, 62
	(IH 100-105	from skull 22-24	20-22	60-63)
EL *Coccothraustes c. japonicus*				
Males: 3	99, 102, 111	17.5, 19.5, 21.7	21, 22, 23	50, 52, 53
Females: 5	101-102 av. 101.6	16-22 av. 18.8	21.5-24.5 av. 22.6	49-55 av. 52
1982 *Mycerobas icterioides*				
Males: 19	128-139 av. 133.3	22.2-25.5 av. 23.6	26-28.5 av. 27.8	82-94 av. 89.4
	(IH 126-136	from skull *c.* 29	*c.* 25	88-97)
Females: 9	124-132 av. 128.5	20.8-23.6 av. 22.4	26.4-28 av. 26.9	83-93 av. 87.9
	(IH 122-128	from skull *c.* 27	*c.*23	88-97)
1983 *Mycerobas affinis*				
Male 1	129	23	26.5	97
	(IH 123,126	from skull 27	26	83)
Female 1	119	21.7	25.8	83
	(IH 121, 132	from skull 27	26	87)
1984, 1985 *Mycerobas carnipes* subspp				
Males				
speculigerus: 2	124, 124	21.5, 23.7	26.5, 26.7	100, 102
	(IH 114-120)			
carnipes: 2	117, 118	19.5, 21.3	25, 27	94, 95
	(IH 115-126)			
Females				
speculigerus: 3	115, 116, 117	20.5, 20.5, 21.2	25.5, 25.5, 26.3	86, 89, 90
	(IH 116-123)			
carnipes: 3	112, 119, 120	20, 20, 23.2	25, 25, 25.5	91, 95, 96
	(IH 116-123)			
1986 *Mycerobas melanozanthos* – Western Population				
Males: 7	126-131 av. 128.5	21-24.1 av. 23	23.2 –24.8 av. 24.1	65-77 av. 71.2
	(IH 122-135	from skull 24-32	22-25	71-83)
Females: 3	129, 130, 132	22.8, 23.1, 24.5	24, 24.5, 26	69, 75, 77
	(IH 119-135	from skull 28-31	22-24	73-77)
1986 *Mycerobas melanozanthos* – Eastern Population				
Males: 3	126, 29, 131	22.7, 23, 25.6	23, 24.5, 26	70, 70, 71
Female: 1	127	23.2	24	65
1989 *Carduelis carduelis caniceps*				
Males: 10	78-82 av. 80.3	12.2-15 av. 13.6	14.2, 15 av. 14.6	47-53 av. 49.6
	(IH MF 79-87	from Skull 16-17	14-15	48-51)
Females: 7	75-79 av. 77.5	12.7-14 av. 13.4	14.3-15.5 av. 14.8	46-50 av. 48.8

MEASUREMENTS PART 40 (*contd.*)

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
EL *Carduelis carduelis paropanisi*				
Male: 1	79	14.1	15	40
	(Dement've 78-84)			
Female: 1	82	14.9	16	48
	(Dement've 74-83)			
EL *Carduelis carduelis niediecki*				
Males: 7	77-85 av. 80.5	11.8-14.5 av. 13	15-16 av. 15.3	47-52 av. 49.8
Females: 4	76-81 av. 78.7	11.6-13.7 av. 12.7	14-15.5 av. 14.8	46-50 av. 48.7
1990 *Carduelis spinoides spinoides*				
Males: 39	74-81 av. 77.1	9.5-11.9 av. 10.6	15-16.5 av. 15.4	42-51 av. 47.7
	(IH 76-81	from skull 14-16	14-16	43-51)
Females: 23	69-77 av. 75	9.5-11 av. 10.3	14.5-16.5 av. 15.8	40-49 av. 44.9
	(IH 72-80	from skull 14-16	14-16	46-50)
1993 *Carduelis thibetana*				
Males: 8	67-71 av. 69.5	8.8-10 av. 9.3	13.3-14.3 av. 13.8	38-43 av. 40.3
	(IH 76-81	from skull 14-16	14-16	43-51)
Female: 1	71	13.3	13	44
	(IH 72-80	from skull 14-16	14-16	46-50)
EL *Carduelis sinica*				
Males: 4	79-93 av. 88.7	10.8-13.3 av.12.5	15.5-20.5 av.18.6	43-60 av.55.7
	(Peter Clement 76-84	10-13	13-19	55-60)
Females: 6	77-85 av. 81	9-12.2 av. 10.9	14.5-21.5 av. 17.6	42-61 av. 49
	(Peter Clement 76.5-85	10-13	13-19	55-60)
EL *Carduelis spinus*				
Male: 1	79	9.6	14.5	44
	(Dement've 68-74.5	*c.* 10	-	45-49)
1994 *Carduelis cannabina bella*				
Males: 5	81-83 av. 81.8	9.2-10 av. 9.6	15.5-16 av. 15.7	54-55 av. 54.8
	(IH 76-84	from skull *c.* 13	*c.* 16	87-90)
Females: 6	76-82 av.79.1	9.5-10.5 av. 9.8	15-16.5 av. 15.9	50-54 av. 53
	(IH 72-83	from skull *c.* 13	*c.* 16	87-90)
1995 *Carduelis flavirostris montanella*				
Males: 2	74, 81	93, 9.5	15.7, 16.7	58, 68
	(IH 77-85	from skull *c.* 11	*c.* 19	55-64)
Female: 1	72	10	16	54
	(IH 73-81	from skull *c.* 11	*c.* 19	55-64)
1996 *Carduelis flavirostris rufostrigata*				
Male: 1	83	9.7	16.7	68
	(IH 77-85	from skull *c.* 11	*c.* 19	55-64)
EL *Carduelis flammea*				
Female: 1	73	7	14	57
	(Peter Clement 67-68	from skull 8-10	14-16	49-58)

MEASUREMENTS PART 40 (*contd.*)

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
1997 *Callacanthis burtoni*				
Males: 9	97-103 av. 99.1	13.7-14.3 av. 13.9	19.5-21 av. 20.5	62-68 av. 65
	(IH 96-104	from skull *c.* 18	*c.* 19	63-65)
Females: 7	94-100 av. 96.1	13.1-14.8 av. 14.1	20-21.7 av. 20.9	60-63 av. 61.6
	(IH 97-100	from skull *c.* 18	*c.* 19	*c.* 61)
1998 *Serinus pusillus*				
Males: 12	73-77 av. 75.2	7-9 av. 8	14-15.5 av. 14.5	52-57 av. 54.2
	(IH 74-80	from skull 9-10	*c.* 15	48-57)
Females: 7	72-78 av. 73.8	7.2-8.5 av. 7.9	14.5-15.3 av. 14.9	49-54 av. 51.4
	(IH 71-75	from skull 9-10	*c.* 15	52-54)
EL *Serinus serinus*				
Male: 1	71	7	13	49
	(Peter Clement 68-77	7-9	11-13	42-49)
EL *Serinus syriacus*				
Male: 1	71	7.2	13.5	46
	(Peter Clement 70-77)			
1999 *Leucosticte nemoricola altaica*				
Males: 20	93-100 av. 96.8	10.5-11.5 av. 11.1	19-21.5 av. 19.8	60-68 av. 65
	(IH 93-100	from skull 12-15	20-21	65-72)
Females: 11	90-99 av. 94.6	10.4-11.5 av. 11.1	19-20.5 av. 19.6	59-64 av. 61.7
	(IH 90-95	from skull 12-15	20-21	64-69)
2000 *Leucosticte nemoricola nemoricola*				
Males: 11	98-103 av. 101	105-11.7 av. 11.1	19.5-22 av. 20.7	66-71 av. 68.8
	(IH 94-105	from skull 12-15	20-21	65-72)
Females: 6	95-99 av. 96.8	11-11.6 av. 11.3	20-21.7 av. 20.8	63-70 av. 66.1
	(IH 90-108	from skull 12-15	20-21	64-69)
2003, 2004 *Leucosticte brandti haematopygia*				
Males: 7	111-122 av. 116.2	11-12.2 av. 11.4	22-23.6 av. 22.6	71-77 av. 74.4
	(IH 112-122	from skull 13-14	20-22	73-82)
Females: 5	108-120 av. 112.2	11-12 av. 11.3	21-24 av. 22.6	68-75 av. 71
	(IH 106-117	from skull 14-15	20-22	69-75)
2006 *Bucanetes githaginea crassirostris*				
Males: 7	85-91 av. 88.4	10.1-11.2 av. 10.4	17-18.7 av. 17.7	45-57 av. 51.6
	(IH 88-93	from skull 12-13	*c.* 19	51-55)
Females: 10	83-89 av. 85.1	9.5-11.6 av. 10.6	17.2-20 av. 18.1	45-50 av. 49
	(83-89	from skull 12-13	*c.* 19	51-55)
2007 *Bucanetes mongolicus*				
Males: 4	88-93 av. 89.7	8.8-9 av. 8.9	17-20 av.18	46-60. av. 54.5
	(IH 84-96	from skull *c.*12	*c.* 17	51-58)
Females: 4	86-90 av. 88	8.5-9.2 av. 8.9	18-20 av. 19	52-58 av. 55
	(IH 84-91	from *c.* 12	*c.* 17	51-52)
2008 *Rhodospiza obsoleta*				
Males: 5	84-91 av. 88.2	11-12.5 av. 11.5	17.5-18.5 av. 18	60-64 av. 62
	(IH 86-92	from skull 13-14	16-18	56-65)
Females: 3	80-85 av. 81.6	10.5-11 av. 10.6	17-17.5 av. 17.5	55-58 av. 56.5
One damaged	(IH 81-87	from skull 13-14	16-18	54-61)

MEASUREMENTS PART 40 (*contd.*)

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
2009 *Rhodopechys sanguinea sanguinea*				
Male: 1	107	13.5	21.5	Nil
	(IH 105-111	from skull *c.* 17	*c.* 19	52-63)
2010 *Carpodacus erythrinus ferghanensis*				
Males: 17	82-89 av. 85.3	10.5-11.5 av. 10.8	18-20.5 av. 19.4	54-60 av. 57.7
	(IH 78-87)			
Females: 8	77-89 av. 80.7	10-11 av. 10.5	17.5-20.5 av. 18.9	51-61 av. 55.1
	(IH 78-84)			
2011 *Carpodacus erythrinus roseatus*				
Males: 49	75-88 av. 84.2	9.5-12 av. 10.5	17-20 av. 18.8	52-62 av. 56.3
	(IH 83-90	from skull 13-15	18-20	54-61)
Females: 34	76-86 av. 81.5	10-11 av. 10.9	18-20.5 av. 20	47-60 av. 55.2
	(IH 80-85	from skull 13-15	18-20	51-60)
2012 *Carpodacus erythrinus kubanensis*				
Male :1	82	10.5	18	57
	(IH 78-87)			
Female: 1	75	11	19.5	53
	(IH 78-84)			
2013 *Carpodacus erythrinus erythrinus*				
Male: 1	85	10.5	20	56
	(IH 81-90	from skull 14-15	*c.* 19	56-61)
Female: 1	80	10.5	20	52
	(IH 78-90	from skull 14-15	*c.* 19	54-59)
EL *Carpodacus erythrinus grebnitzkii*				
Males: 2	83, 85	10.6, 11	19.5, 19.5	56, 57
	(Dement've 78.2-85.5)			
2014 *Carpodacus nipalensis kangrae*				
Males: 4	87-90 av. 88.7	10.8-11.5 av. 11.2	20-23 av. 21.7	59-63 av. 61.5
	(IH 81-95	from skull 13-16	20-23	53-66)
2015 *Carpodacus nipalensis nipalensis*				
Males: 12	84-94 av. 89.9	11.3-12 av. 11.5	21-23 av. 22.2	57-65 av. 62
	(IH 81-95	from skull 13-16	20-23	53-66)
Females: 4	80-86 av. 83.5	10.7-12.5 av. 11.4	21.5-22.5 av. 21.8	54-61 av. 58.2
	(IH 74-90	from skull 13-16	20-23	56-68)
2017 *Carpodacus rhodochrous*				
Males: 21	70-80 av. 73.9	9.5-10.7 av. 10.1	19-20.5 av. 20	54-64 av. 59.8
	(IH MF 69-71		*c.* 20	*c.* 58)
Females: 11	69-72 av. 70.2	10-10.7 av. 10.2	19.5-20.5 av. 20.1	51-58 av. 55.1
2017a *Carpodacus vinaceus vinaceus*				
Male: 1	74	11	20	57
	(IH M/F 69-71	-	c 20	c 58)
2018 *Carpodacus rhodochlamys grandis*				
Males: 15	87-97 av. 92	13-14.8 av. 13.8	21-24.5 av. 22.6	70-84 av. 74
	(IH 90-96	from skull 18-20	20-22	69-74)
Females: 9	85-94 av. 90.4	12.5-15 av. 13.9	21.7-24 av. 22.6	70-80 av. 73.7
	(IH 88-92	from skull 18-20	20-22	65-70)

MEASUREMENTS PART 40 (*contd.*)

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
2020 *Carpodacus thura blythi*				
Males: 9	83-87 av. 85.2	10.7-12 av. 11.6	23-24.5 av. 23.5	69-75 av. 71.8
	(IH 81-87	from skull *c.* 14	*c.* 25	*c.* 75)
Females: 2	81, 82	12, 12	22.5, 24.5	67, 70
	(IH 80-83	from skull *c.* 14	*c.* 25	*c.* 65)
2021 *Carpodacus thura thura*				
Male: 1	83	11.5	24	73
	(IH as in 2020)			
Female: 1	83	11.4	24.3	71
2023 *Carpodacus pulcherrimus pulcherrimus*				
Males: 6	77-79 av. 78.1	10-11 av. 10.5	20-21 av. 20.2	59-64 av. 62
	(IH 74-81	from skull *c.* 13	*c.* 20	62-64)
Female: 1	77	10.2	20.7	60
	(IH 74-78	from skull *c.* 13	*c.* 20	62-64)
2025 *Carpodacus edwardsii rubicunda*				
Males: 2	82, 84	11.7, 12	23.5, 25.5	63, 64
	(IH 79-85	from skull 14-16	22-25	61-67)
Females: 3	80, 81, 83	12, 12, -	23, 24, 24	65, 66, 66
	(IH 77-82	from skull 14-16	22-25	59-66)
2027 *Carpodacus rubicilla severtzovi*				
Males: 4	115-121 av. 118	13.8-15.3 av. 14.5	23-24.5 av. 23.8	85-91 av. 88.5
	(IH 116-123	from skull 18-20	22-23	86-91)
2028 *Carpodacus rubicilloides lucifer*				
Males: 7	108-114 av. 111.7	14-16 av. 15	24-26 av. 24.9	86-94 av. 91.8
	(IH 105-115	from skull *c.* 18	24-25	84-92)
Female: 1	105	15	24.5	80
	(IH 97-108	from skull *c.* 18	24-25	84-92)
2030 *Carpodacus puniceus humiii*				
Males: 3	110, 112, 113	15.3, 16, 16	24.5, 25, 26	77, 80, 80
	(IH 111-120	from skull 18-20	24-26	76-88)
Females: 1	111	14.5	25	74
	(IH 113	from skull 20	25	81)
2031 *Carpodacus puniceus puniceus*				
Male: 1	112	16.2	25	78
	(IH 106-120	from skull 17-19	23-24	72-85)
2032 *Loxia curvirostra himalayensis*				
Male: 1	91	17.2	18.5	55
	(IH 77-91	from skull 18-20	15-17	50-56)
Female: 1	84	16.5	15.6	53
	(IH 80-88	from skull 18-20	15-17	50-56)
EL *Loxia c. curvirostra*				
Female:1	94	18.2	17.5	57
	(Dement've 94-97)			
EL *Loxia leucoptera bifasciata*				
Male: 1	93	17	17.3	61
	(Dement've 82-96)			

MEASUREMENTS PART 40 (*contd.*)

	Wings (mm)	Bill (mm)	Tarsus (mm)	Tail (mm)
2033 *Propyrrhula subhimachala*				
Male: 1	101	12.5	24.5	76
	(IH 92-110	from skull 13-18	21-25	74-83
Female: 1	94	13	24	80
	(IH 91-97	from skull 13-18	21-25	74-79)
2034 *Haematospiza sipahi*				
Males: 9	98-108 av. 102	14-16 av. 14.9	19.8-22 av. 21.1	62-71 av. 65.6
	(IH 98-108	from skull 16-20	19-22	63-70)
Females: 6	99-100 av. 99.6	14.4-15.5 av. 15.2	20.5-22.2 av. 21.2	59-65 av. 61.6
	(IH 95-102	from skull 16-20	19-22	60-66)
2035 *Pyrrhoplectes epauletta*				
Males: 3	77, 79, 79	11.5, 11.5, 11.6	19.5, 19.5, 20	57, 59, 60
	(IH 75-80	from skull 12-15	19-20	54-62)
Female: 1	76	11.8	20	59
	(IH 74-77	*c.* 12	19-20	53-56)
2036 *Pyrrhula nipalensis nipalensis*				
Males: 5	84-88 av. 86	10.2-11 av. 10.7	16-17.5 av. 17	74-78 av. 76.4
	(IH 83-90	from skull 11-14	*c.* 17	70-80)
Females: 3	82, 85, 85	10.5, 11.3, 12	16, 16, 17	68, 70, 72
	(IH 80-87	*c.* 12	*c.* 17	*c.* 70)
2039 *Pyrrhula erythrocephala*				
Males: 39	73-81 av. 78.1	9-10.5 av. 9.6	16-18.5 av. 17.1	52-70 av. 62.4
	(IH 72-81	from skull 10-13	17-20	60-70)
Females: 11	75-82 av. 78.2	9.5-10 av. 9.7	17-17.7 av. 17.4	60-67 av. 64
	(IH 76-80	from skull 10-13	17-20	63-67)
2040 *Pyrrhula aurantiaca*				
Males: 7	81-83 av. 82	9.4-9.6 av. 9.5	16.5-17.5 av. 16.9	56-61 av. 58.8
	(IH MF 80-83		*c.* 18	57-58)
Females: 2	81, 81	9.1, 9.5	17, 17.5	59, 59
EL *Pyrrhula pyrrhula*				
Males: 2	87, 94	10,11	17.5, 19	64, 68
Female: 1	87	10	18.5	64
EL *Pyrrhula pyrrhula rossikowi*				
Male: 1	91 (Dement've 85.5-93.5)	11	18.5	71
EL *Uragus sibiricus sibiricus*				
Male :1	76	7.5	15	85
	(Peter Clement			
	70-79	8-9	-	75-85)

orange rufous collar of the male called for a critical look before separating them from *icterioides*.

Measurements on p. 361.

1984 ***Mycerobas carnipes speculigerus*** (Brandt) (N. Persia). Persian White-winged Grosbeak 3: 104.

5: 2 males, 3 females.

2 Uzbeck Academy 1 Kashgar, China, 2 Harboi, Baluchistan.

Uzbeck specimens were collected in 1926 and the Harboi specimens in 1917; Kashgar specimen is without a date.

Measurements on p. 361.

1985 ***Mycerobas carnipes carnipes*** (Hodgson) (Nepal). Himalayan White-winged Grosbeak 3: 104.

5: 2 males, 3 females.

3 Pyas, Kishtwar, Kashmir, 2 Chini Bushahr, Simla Kanda Camp, Himachal Pradesh.

The Kishtwar specimens were collected by Crump in 1907 and the other two by A.E. Jones on 8.vii.1926. The key in the HANDBOOK states that the nominate race is darker and *speculigerus* is paler. This difference is not visible in the specimens and they have been separated according to distribution.

Measurements on p. 361.

1986 ***Mycerobas melanozanthos*** (Hodgson) (Nepal). Spotted-winged Grosbeak 3:105.

14: 10 males, 4 females.

2 Dharmsala, 5 Simla, 2 Lambathach, 1 Garhwal, 1 Sikkim, 1 Darjeeling, 1 Tama, 1 Shamgong, C. Bhutan.

Out of the 14 specimens, 10 (7 males and 3 females) are from Western Himalayas and 4 (3 males and 1 female) from eastern regions. The eastern birds are notably different, smaller with a shorter tail and darker, especially the deeper sulphur yellow underparts. This is not due to the aging of the specimens. Specimen No. 7118 collected from Sikkim by H.J. Walton on 18.iv.1902 is darker yellow than specimens from Shimla collected on 4.iv.1922 and 3.iv.1927 by A.E. Jones. *There are enough differences to treat them as a separate race after examining a larger series.*

Measurements on p. 361.

1987 ***Carduelis carduelis major*** Taczanowski (Turkestan). Siberian Goldfinch 3: 149.

Nil.

1988 ***Carduelis carduelis subulata*** (Gloger) (Yenisei). Central Asian Goldfinch 3: 153.

Nil.

1989 ***Carduelis carduelis caniceps*** Vigors (Himalayan Mountains = Simla-Almora area). Grey-headed Goldfinch 3: 150.

20: 10 males, 7 females, 3 unsexed.

1 Kain, Persia (Iran), 4 Chitral, 1 Malakand, Peshawar, 1 Murree, Rawalpindi, 2 Chhoi, near Campbellpur, 1 Chashmashahi, Kashmir Valley, 1 Konain, Jaunsar, 2 Solon, Bhagat State, Simla Hills, 4 Simla, 1 Lambathach, 1 Bampa, Nita, Garhwal, 1 no locality (purchased in Bombay market).

Males have a crimson chin, distinguishing them from females, which have only a light crimson border at the base of the bill.

Measurements on p. 361.

EL ***Carduelis carduelis paropanisi*** Kollibay (Naryn Turkestan). Grey-headed Goldfinch

2: 1 male, 1 female

The specimens dated 22.vi.1925 are from Uzbeck Academy, Tashkent and are marked *C.c. paropanisi* on the original label. They look very similar to our specimens of *C.c. caniceps*, but have slightly longer, heavier bills.

Measurements on p. 362.

EL ***Carduelis carduelis niediecki*** Reichenow Asia Minor.

11: 7 males, 4 females

2 Dohuk, Kurdistan, 1 Sulaimaniya, Iraq, 1 Amara, Mesopotamia, 5 Shiraz, Persia (Iran), 1 Shustar, S. Persia, 1 Mishern, Persian Gulf.

This is the Asia Minor race of Goldfinch. Differs from *C.c. caniceps* in having white ear coverts, and black crown and nape. Female is slightly less bright.

Measurements on p. 362.

1990 ***Carduelis spinoides spinoides*** Vigors (Himalayas = Simla). Himalayan Greenfinch 3: 160.

72: 39 males, 23 females, 10 unsexed.

3 Liddar Valley, 1 Gulabgarh, Kishtwar, Kashmir, 1 Jagadri, Ambala, 3 Dalhousie, 1 Dakuri, 4 Mornaula, 1 Kariakustu? 2 Thunsi, Nepal, 1 Solon, Bhagat St., 3 Mashobia, 1 Garsa, Kulu, 2 Chini, 22 Simla, 1 Kumaon, 3 Garhwal, 1 Naini Tal, 1 Baria Bastee, Darjeeling, 2 Honka W. Bh., 1 Tama, 3 Batase, 1 Mangdechu, 1 Bumthang, C. Bhutan, 3 Warmrong, E. Bh. 6 Khosela, Bh. 2 Tirhut, Darbhanga, Bihar, 1 Dre, Yigomg Valley, 1 no locality.

The west Himalayan birds were collected in 1877 to 1934, and Bhutan birds during 1966 to 1973. Eastern birds have darker upper parts and bright yellow underparts. The difference may be due to fading in the museum.

Measurements on p. 362.

1991 ***Carduelis spinoides taylori*** (Kinnear) (Lilung, Tsangpo Valley, SE Tibet). Tibetan Greenfinch.

Nil.

1992 ***Carduelis spinoides heinrichi*** Stresemann (Mt. Victoria). Mt. Victoria Greenfinch 3: 160.

Nil.

1993 ***Carduelis thibetana*** (Hume) (Borders of Sikkim and Thibet). Tibetan Siskin 3: 162.

9: 8 males, 1 female.

6 Chimakothi, West 1 Shamgong, Central, 2 Warmrong, East Bhutan.

Rump of male bright olive green with yellow wash (in female, olive green streaked like the back) HANDBOOK (Vol. 10, p. 140, 1974) erroneously mentions the male rump as "brighter yellow", Baker (Vol. 3, p. 162, 1926) is more exact when he says "upper plumage and wing coverts olive yellow-green, rump brighter and more yellow".

Measurements on p. 362.

EL ***Carduelis sinica*** (Linnaeus) (China, restricted to Macao by Jaconi). Oriental Greenfinch.

10: 4 males and 6 females

All the birds are from Temple of Heaven, Peking.

Measurements on p. 362.

EL ***Carduelis spinus*** (Linnaeus) (Europe; restricted to Sweden by Hartert 1903). Siskin.

1 Male from *Residency Baghdad.*

Measurements on p. 362.

1994 ***Carduelis cannabina bella*** (Brehm) (Kashmir). Eurasian Linnet.

12: 5 males, 6 females, 1 unsexed.

1 Sulaimaniya, Iraq, 1 Dohuk, Kurdistan, 4 Meshed, Persia (Iran), 2 Shustar, S. Persia, 1 Choi, 3 Campbellpur, W. Punjab.

The birds were collected during 1918 to 1928. The pinkish red forehead is faded and one has to look hard for the faint reddish tinge on the streaked head of the male. Breast is pinkish brown.

Measurements on p. 362.

1995 ***Carduelis flavirostris montanella*** (Hume) (Arpalak River, Yarkand). Stoliczka's Twite 3: 157.

4: 2 males, 1 female, 1 unsexed.

2 Chitral, 1 Rupshu, Kashmir, 16000', 1 Puga Valley, Ladakh.

The key in the HANDBOOK requires these birds to be paler and more sandy above than *rufostrigata*, which is darker and more rufescent. But the specimens of these two races in the Collections are not in good condition, and were separated according to locality. The Rupshu specimen collected by A.E. Jones in 10.viii.1926 is marked *ladacensis*, which is now synonymised with *montanella*.

Measurements on p. 362.

1996 ***Carduelis flavirostris rufostrigata*** (Walton) (Khamba Jong, Tibet). Tibetan Twite 3: 157.

3: 1 male, 2 females.

2 Tingri, 1 Gyantse, Tibet.

No. 7363 collected from Tingri on 10.vii.1921 shows a pale pink rump.

Measurements on p. 362.

EL ***Carduelis flammea*** (Linnaeus) (Norrland, Sweden Redpoll). Common Redpoll.

One female specimen from Ussuriland, Russia marked *Acanthis flammeus*.

Measurements on p. 362.

1997 ***Callacanthis burtoni*** (Goud) (Himalaya = Srinagar). Spectacled Finch 3: 152.

16: 9 males, 7 females.

2 Chitral, 1 Daugail, Kishtwar, 1 Danlong, 2 Liddar Valley, 2 Kashmir, 8 Simla, NWH.

The HANDBOOK describes the male bird as having black wing, spotted with white. Actually it is the bold white tips to greater coverts, tertials, secondaries and two inner primaries that form the 'spots'. As regards the tail, the outer margins of the outer rectrices are black and there is a long oval white patch on the inner margin of the outer two pairs of rectrices. The pinkish red chin and throat are not apparent in these specimens. They are dark brown with rufous tips to feathers, giving a mottled appearance. In female, the tips of wing feathers ("spots") are dull brown.

Measurements on p. 363.

1998 ***Serinus pusillus*** (Pallas) (Caucasus). Fire-fronted Serin 3: 158.

27: 12 males, 7 females, 8 unsexed.

1 Tashkent Uzbeck Academy, 2 Khasafir monastery, N. Dohuk, Kurdistan, 1 Kidri, Kain, 1 Tehran, 1 Shustar, 2 Amirabad, Birjand, E. Persia, 3 Chitral, 3 Bostan Terek, 1 Quetta, Baluchistan, 1 Deosai Pass, Kashmir, 1 Rumbleton, Ladakh, 8 Simla, 2 Garhwal.

The specimens were collected from 1888 to 1930, except the Tashkent specimen, which was collected in 1960. Males appear to have a darker head and brighter scarlet forehead than the females. Throat is blackish; mantle, upper part of belly and flanks heavily streaked due to the fulvous edges of the dark brown feathers. No yellow is visible in the specimens.

Measurements on p. 363.

EL ***Serinus serinus*** (Linnaeus) Southern Europe. Serin.

One male from *Budapest, Hungary* collected on 25.v.1959.

A small streaked finch with yellow forehead, greenish yellow rump, chin, throat and breast.

Measurements on p. 363.

EL ***Serinus syriacus*** Bonaparte. Syrian Serin

One male collected from Dohuk, Kurdistan on 22.xii.1922 by La Personne.

Very small finch with yellow forehead, rump, throat and heavily streaked mantle. Highly restricted distribution in the Middle East.

Measurement on p. 363.

1999 ***Leucosticte nemoricola altaica*** (Eversmann) (Uimon, Attai). Western Hodgson's Mountain-Finch.

38: 20 males, 11 females, 7 unsexed.

2 Aktala, Chinese Turkistan, 5 Chitral, 1 Bostan Terek, 1 Kazing Bastie? 5 Kashmir, 1 Kishtwar, 3 Sonamarg, 1 Tragbal Pass, 1 Painzalmurg, Kashmir, 1 Pindari Glacier, 5 Dharmsala, 2 above Chini, 4 Narkunda, 6 Simla.

The key in the HANDBOOK separates *altaica* from the nominate race on the basis of the colour of axillaries – pale ashy in the former and pale yellow in the latter race. This difference cannot be observed in any of the specimens. They were separated according to distribution.

Specimens of *altaica* were collected from 1902 to 1945, 6 specimens were collected by Br. Navarro in 1966, from Simla. Specimens of the nominate race were collected in 1952, 1953, 1955 and 1967 by Sálim Ali and party. The nominate race is appreciably darker than *altaica* specimens. This is not due to fading of the specimens in the Collection. Females in both the races are paler than the males.

Measurements on p. 363.

2000 ***Leucosticte nemoricola nemoricola*** (Hodgson) (Nepal). Eastern Hodgson's Mountain-Finch 3: 191.

18: 11 males, 6 females, 1 unsexed.

1 Nyemjam, S. Tibet, 3 Lachen, N. Sikkim, 2 Chungthang, 3 Lachung, N. Sikkim, 1 Deutam, W. Sikkim, 2 Phalut, Darjeeling, 5 Shamgong, C. Bhutan.

Measurements on p. 363.

2001 ***Leucosticte brandti brandti*** Bonaparte (Siberia, *errore* = Turkestan). Brandt's Mountain Finch 3: 193.

Nil.

2002 ***Leucosticte brandti pamirensis*** Severtzov (Pamir). Pamir Mountain-Finch 3: 193.

Nil.

2003, 2004 ***Leucosticte brandti haematopygia*** (Gould) (Thibet). Himalayan Mountain-Finch 3: 194.

15: 7 males, 5 females, 3 unsexed.

1 Chinese Turkistan, 3 Chitral Drosh, 1 Borgi Pass, Baltistan, 2 Rupshu, Kashmir, 2 Polokanka, 1 Puga valley, 1 Sasar Pass, 1 Khardong, Ladakh, 1 Upper Kurta Valley, 1 East Everest, 1 Thungla, S. Tibet.

The specimens date back to 1902-1926 except three, 2 males and 1 female, collected by Sálim Ali and Hussain on July 17 and 18, 1976 from Puga Valley, Sasar Pass and Khardong in Ladakh. All males have scaly pink rump due to the greyish-brown feathers of the rump having pink tips. The Ladakh female also has a similar but less bright pink rump. The forehead and face are sooty black in males and slightly paler in females.

Measurements on p. 363.

2005 ***Leucosticte brandti pallidior*** Bianchi (Karasai, Nan Shan). Kun Lun Mountain-Finch 3: 194.

Nil.

2006 ***Bucanetes githaginea crassirostris*** (Blyth) (Afghanistan). Trumpeter Finch 3:141.

17: 7 males, 10 females.

1 Duzdap, Sistan 5 Charbar, Persian Gulf, 1 Kelat, Baluchistan, 1 Wahir, 25 miles southwest of Khojdar, 2 Chitral, 6 Johi, Larkana, Sind, 1 Karachi.

A small, sandy brown finch with light grey head, pink forehead, lores and outer edges of remiges, pink wash to underparts and rump in males. Female without pink in the plumage. Can be separated without much difficulty following the key in HANDBOOK. May be confused with *mongolica*, three specimens of which were registered as this species.

Measurements on p. 363.

2007 ***Bucanetes mongolicus*** (Swinhoe) (Nankow Pass). Mongolian Finch 3: 142.

8: 4 males, 4 females.

1 Sehdeh, Birjand, 1 Birjand, 1 Kaidasht Pass, Kain, Persia, 1 Gilgit, 4 Chitral.

The specimens from Persia, collected by V.S. La Personne in 1926 and 1927, were identified and registered as *G. crassirostris*. But they have a distinctly smaller bill compared to the stouter bill of *githaginea*, pink is absent or very little in the plumage and the mantle streaked, contrary to the plain mantle of *githaginea*.

Measurements on p. 363.

2008 ***Rhodospiza obsoleta*** (Lichtenstein) (Buchara). Black-billed Finch 3:143.

8: 5 males (4 by pl), 3 females (1 by pl)

1 Bagdad, Iraq, 2 Chaman, 2 Quetta, Baluchistan, 3 *Kashgar, China.*

The male is distinct from the female unlike the remarks in the HANDBOOK. Tertials are black with white edges in males and brown with pale brown edges in females. Wing and tail pattern are bright in male and dull in female. Five unsexed specimens were separated (four males and one female) according to the plumage.

The specimens were collected from 1902 to 1926. Many are in poor condition and two are highly damaged.

Measurements on p. 363.

2009 ***Rhodopechys sanguinea sanguinea*** (Gould) (Erzerum). Crimson-winged Finch 3: 144.

1 male from Chitral.

There is only one specimen collected by H.J. Fulton on July 8, 1902. It is without a tail and is in poor condition. The outer edges of the wing feathers are pink, forming a large pink wing patch with a crimson touch, and the white tips to the secondaries are prominent.

Measurements on p. 364.

2010 ***Carpodacus erythrinus ferghanensis*** (Kozlova) (Shah-dara Tadzhik S.S.R.). Turkestan Rosefinch 3: 136.

25: 17 males, 8 females.

8 Chitral, 4 Chitral Drosh, 4 Zangalwar, Badrawar, 1 Kishtwar, 3 Dachigam, 1 seven miles below Yus, 2 Sooknas, Wardwar, 1 Kashmir, 1 Kargil, Ladakh.

The key in the HANDBOOK separates the four races of *erythrinus* on the intensity and extent of the rose pigment. Males of *ferghanensis* are darker with a crimson head, chin, throat and rump. Most of our specimens date back to 1897 through 1907, and it is quite difficult to separate them on the basis of colour as they have faded. This race has been separated according to the locality recorded. All the specimens were collected during their breeding period from breeding localities of the race. Three specimens in end April, 15 in May and 7 from June-August.

Measurements on p. 364.

2011 ***Carpodacus erythrinus roseatus*** (Blyth) (Sold in Calcutta [=Kolkata]). Indian Rosefinch 3: 137.

84: 49 males, 34 females, 1 unsexed.

1 Pindari, 2 Taradevi Patiala, 1 Lahore, 1 Jagadri, 3 Ambala, 1 Kufri, Koti State, 10 Simla, N.W.H. 2 Joshimath, 1 Almore, 2 Guptakashi, 1 Yalai, Garhwal, 1 Delhi, 5 Bharatpur, 1 Balaram, Palanpur, 1 Vaghjipur, Mehsana Dt., 1 Juna, Rajpipla, Gujarat, 2 Chikalda, Berar, 3 Nasik, 2 Ahmednagar, 1 Shil, Thana, 1 Godbunder, Salsette, 1 Borivli, 1 Belapur, 2 Khandala, 1 Rewas, Alibag, 1 Kalian? 2 Medha, 3 Satara, Maharashtra, 1 Jog, Karwar, 2 Bangalore, 1 Anaikatty, Gudalore, 2 Kil, Kottagiri, Ooty, Nilgiris, 1 Maraiyur, Travancore, 1 Kurumbapatti; Salem, Tamil Nadu, 1 Anantgiri, 5 Sankrametta, Vizagapatnam, 1 Bailadila, Bastar, 1 Nilgiri, Orissa, 2 Baghownie, 4 Tirhut, 4 Gedu, W. Bhutan, 1 Geylegphug, C. Bhutan, 1 Cachar, 2 *North Shan States.*

The typical colour of this race, deep carmine is seen in a male collected from Gedu, W. Bhutan in October 1968. A similar colour with less intensity is visible in a male from N. Nilgiris collected in March 1977. Two birds from Joshimath, Garhwal collected on 25.v.1899 despite probable fading shows the carmine colour of the breeding male, also 3 specimens collected by A.E. Jones from Simla in April, May & June.

17 males collected in November, December and January, have pink chin, throat and breast. The feathers have light cream edges, giving a somewhat scaly appearance. A bird collected by C.M. Inglis from Darbhanga on 15.vi.1877 also has a similar plumage. 11 males collected during March and April are in the process of changing into the breeding plumage by abrasion of the edges of the feathers.

Among females, birds collected from Bhutan in 1968 are the darkest, with very distinct, sharp, dark streaks on the underparts. A bird from Bharatpur, Rajasthan (24.ix.1962) also has similar streaks.

Measurements on p. 364.

2012 ***Carpodacus erythrinus kubanensis*** Laubmann (Kuban dist., Caucasus). Caucasus Rosefinch 3: 136.

2: 1 male, 1 female

1 *Charbar, Persian Gulf,* 1 Liddar Valley, Kashmir.

The male specimen collected on 22.viii.1928 is marked by Sálim Ali as *kubanensis*; the Charbar specimen collected by W.D. Cumming on 6.ii.1913 is a female. A poorly differentiated race according to Vaurie (IH.10:166). Ticehurst (*JBNHS* 32: 345) stated that it is a very poor race as so many cannot be placed. According to Whistler (*JBNHS* 36: 837) it is useless to recognize the intermediate race *kubanensis*.

Measurements on p. 364.

2013 ***Carpodacus erythrinus erythrinus*** (Pallas) (Volga, South Russia). Common Rosefinch 3: 135.

2: 1 male, 1 female

1 Jaithari, 1 Dodi, Malwa, Bhopal, Central India.

These specimens were collected by Sálim Ali on January 19 and 31, 1938 and identified by H. Whistler as the nominate race. There may be more specimens of this race, *ferghanensis* and *kubanensis* mixed with *roseatus,* since specimens in non-breeding (winter) plumage are difficult to separate.

Measurements on p. 364.

EL ***Carpodacus erythrinus grebnitzkii*** Stejneger (Kamchatka). Eastern Common Rosefinch

2 males from *Peking, China.*

Measurements on p. 364.

2014 ***Carpodacus nipalensis kangrae*** (Whistler) (Dharmsala, Kangra Dist., NW Himalayas). Garhwal Dark Rosefinch 3: 146

4 males.

1 Pyas, Kishtwar, Kashmir, 1 Lakkar, behind Dharmsala, 1 Pindari Glacier, 1 Pindari Valley, Phurtia, Garhwal dist.

Collected in 1907, 1921 and two in 1924. Paler than the nominate race.

Measurements on p. 364.

2015 ***Carpodacus nipalensis nipalensis*** (Hodgson) (Nepal, Central and Northern regions). Nepal Dark Rosefinch 3: 146.

16: 12 males, 4 females

1 Chitlang, 2 Godavari, 1 Nepal Valley, 1 Phalul, 1 N.P. Darjeeling, 4 Temi, W. Sikkim, 2 Tama, C. Bhutan, 3 Wamrong, E. Bhutan, 1 *Loi Lem*, Burma (Myanmar).

A darker bird than *kangrae*, both on the upper as well as underparts. The unsexed specimen in male plumage from Loi Lem was initially placed in *intensicolor,* but it has no discernable difference from the nominate race, hence it is included here. Cheng Tso-Hsin synonymised *intensicolor* with the nominate race in A SYNOPSIS OF THE AVIFAUNA OF CHINA (1987).

Measurements on p. 364.

2016 ***Carpodacus rubescens*** (Blanford) (Sikkim). Blanford's Rosefinch 3: 148.

Nil.

2017 ***Carpodacus rhodochrous*** (Vigors) (Himalayan Mountains = Simla-Almora area). Pink-browed Rosefinch 3: 129.

32: 21 males, 11 females.

1 Ghora Gali, Muree Hills, Rawalpindi, 1 Danlong, Kishtwar, 4 Liddar Valley, 1 Dachigam, Kashmir, 1 Keonthal,

1 Koti, 14 Simla, NWH, 4 Badrinath, 1 Flaghill, E. Mussoorree, 2 Pindari, 1 Nila Valley Garhwal, 1 Gyantse, Tibet.

The specimens date back to 1899 (Maj. H.T. Walton) to 1928 (V.S. La Personne) and a badly prepared female specimen from "Flaghill, Mussorie" collected by Robert Waltner in 1973. Most of the specimens are in poor condition, yet identifiable.

Measurements on p. 364.

2017a ***Carpodacus vinaceus vinaceus*** Verreaux (Mountains of Chinese Tibet). Vinaceous Rosefinch 3: 133.

1 Male from North Shan States, Burma (=Myanmar) collected by Capt. H. Wood, undated and labelled as "*C. vinaceous*" (sic). A much darker bird than the previous species. Deep crimson crown, crimson suffused with brown on back and underparts, light crimson rump, two white spots on tertials, wings and tail dark brown.

Measurements on p. 364.

2018 ***Carpodacus rhodochlamys grandis*** Blyth (Range beyond Simla). Red-mantled Rosefinch 3: 128.

25: 15 males, 9 females, 1 unsexed.

1 Tashkent, Uzbeck, 3 Chitral, 1 Chitral Drosh, 1 Chitral Ghairat, 2 Choi, nr Campbellpur, 5 Harboi, Baluchistan, 1 Koti, 1 Mashobra, Koti, 7 Simla NWH, 1 *Yangihissar, Kashgar*, 2 *Kashgar, China.*

Both males and females are very similar to *rhodochrous*, but can easily be separated due to large size and heavier bill of *rhodochlamys*.

Two of the Kashgar specimens (one male and one unsexed) were collected by F. Stoliczka during the Forsyth's expeditions in December 1873 and the third, a female in 1930. 6 males are in female plumage. The Harboi specimens collected in August 1917 by Capt. J.E.B. Hotson are the palest; both males and females are sandy brown with dark brown streaks on the mantle.

Measurements on p. 364.

2019 ***Carpodacus rodopeplus rodopeplus*** (Vigors) (Himalayan Mountains, restricted to Simla-Almora area). Spot-winged Rosefinch 3: 130.

Nil.

2020 ***Carpodacus thura blythi*** (Biddulph) (Gilgit, "close to the Indus"). Kashmir White-browed Rosefinch 3: 12.

11: 9 males, 2 females.

1 Astan Marg, Liddar Valley, 1 Pyas, 1 Danlong, Kishtwar, 3 Fagu, Simla Hills, 1 Simla, 1 Simla Hills, 2 Nila Valley, 1 Garhwal.

They are somewhat similar to Pink-browed Rosefinch *rhodochrous* and Red-mantled Rosefinch *rhodochlamys*, but can be easily separated from the former in being larger, and from the latter in being smaller and darker. They have two wing bars, the pinkish supercilia join at the forehead and are iridescent. The females are different from those of both the above species in having rufous brown throat and deep olive yellow, heavily streaked rump.

Measurements on p. 365.

2021 ***Carpodacus thura thura*** Bonapart & Schlegel (Himalayas = Sikkim). Sikkim White-browed Rosefinch.

3: 1 male, 1 female, 1 unsexed.

All three are from Lachen, N. Sikkim, collected by Sálim Ali in February and March 1952, are in female plumage. They are darker than *blythi,* snuff brown with blackish-brown streaks, finer on the crown and broad on the mantle.

Measurements on p. 365.

2022 ***Carpodacus thura femininus*** Rippon (Yangtze River, W. Yunnan). Yunnan White-browed Rosefinch 3: 125.

Nil.

2023 ***Carpodacus pulcherrimus pulcherrimus*** (Moore) (Nepal). Himalayan Beautiful Rosefinch 3: 126.

7: 6 males, 1 female.

1 Above Chini, Bashahr, Punjab, 5 Niti Pass, 1 Badrinath, Garhwal.

Six specimens collected by Maj. H.J. Walton in May-June 1899, some marked as this species, are in very poor condition. The seventh, an unsexed (male by plumage) collected by H.W. Wait in May 1941 is in fairly good condition and identifiable as *pulcherrimus.*

Measurements on p. 365.

2024 ***Carpodacus pulcherrimus waltoni*** (Sharp) (Gyantse, S. Tibet). Tibet Beautiful Rosefinch 3: 127.

Nil.

2025 ***Carpodacus edwardsii rubicunda*** (Greenway) (Sikkim) Dark-rumped Rosefinch 3:131.

5: 2 males, 3 females.

3 Lachung, N. Sikkim, 1 Darjeeling, 1 Chimakothi, W. Bhutan.

The Darjeeling specimen, a female, was collected and marked 'Edward's Rose Finch' by C.M. Inglis in August 1905. The rest of the specimens were collected by Sálim Ali and identified by him. The male differs from similar finches like *rhodochlamys* and *thura* in having a rufous brown rump, contra pinkish and much darker above than both these species. Female is very dark rufous brown with indistinct streaks on the belly.

Measurements on p. 365.

2026 ***Carpodacus trifasciatus*** Verreaux (Mountains of Chinese Tibet, restricted to Paohing, eastern Sikang by Vaurie). Three-banded Rosefinch

Nil.

2027 ***Carpodacus rubicilla severtzovi*** Sharpe (Turkestan and Yarkand = Toghrasu near Shabulla, Karakoram). Common Great Rosefinch 3:139.

5: 4 males, 1 unsexed.

1 Chinese Turkestan, 1 Indus Valley below Upshi, 1 Hansi, 1 Tharcha, Losar, 1 Kioto, Spiti, Punjab.

The Tharcha male is in female plumage. Can be confused only with *rubicilloides* due to similar size, but paler with indistinct streaks at back, almost unstreaked nape and diffused white spots on crown and underparts separate them.

Measurement on p. 365.

2028 ***Carpodacus rubicilloides lucifer*** R. & A. Meinertzhagen (Chusha, Southern Tibet). Streaked Great Rosefinch 3: 198.

8: 7 males, 1 female.

3 Puga Valley, 1 Ladakh, 2 Gyantse, 2 Khaita, S. Tibet.

Can be confused only with *rubicilla* from which it differs in being darker, having distinctly streaked nape and mantle, and the white spots on the red crown and underparts smaller and well defined.

Measurements on p. 365.

2029 ***Carpodacus puniceus kilianensis*** Vaurie (North side of the Kiliam Pass at 15,000', Western Kun Lun, Sinkiang). Kun Lun Red-breasted Rosefinch.

Nil.

2030 ***Carpodacus puniceus humii*** (Sharpe) (Kotegarh, restricted by Vaurie, 1956). Western Red-breasted Rosefinch 3: 121.

4: 3 males, 1 female.

1 Lachha Lang Pass, Ladakh, 1 Chini-Kanda, Punjab, 2 Garhwal.

Garhwal specimens, male and female were collected in June and July 1910 by S.L. Whymper and the rest by A.E. Jones in July 1937.

Longer and narrower bill, near absence of white spots on the red forehead and brown crown separate the males from similar male finches *C. rubicilla and C. rubicilloides.*

Measurements on p. 365.

2031 ***Carpodacus puniceus puniceus*** (Blyth) (Himalaya = Nepal). Eastern Red-breasted Rosefinch 3: 120.

3: 1 male, 2 unsexed.

1 East Everest, Tibet, 1 Lapchikang, 1 Upper Kharta Valley, S. Tibet.

Darker and more heavily streaked than the previous race *humii* and have distinctly smaller bill. Females are very similar to *rubicilloides* females, but darker with broader streaks and smaller bills.

Measurements on p. 365.

2032 ***Loxia curvirostra himalayensis*** Blyth (Nepal). Red Crossbill 3: 115.

2: 1 male, 1 female.

They are from Chapcha, W. Bhutan collected by Sálim Ali in November 1968.

Measurements on p. 365.

EL ***Loxia curvirostra curvirostra*** Linnaeus (Europe, restricted to Sweden).

One female dated 5.iii.1932 from a museum in the Soviet Union. It is a larger and paler version of *himalayensis* female, under which it was registered.

Measurements on p. 365.

EL ***Loxia leucoptera bifasciata*** Brehm (Thuringia). Siberian White-winged Crossbill.

1 male from *NE Baikal* marked as the present species.

Measurements on p. 365.

2033 ***Propyrrhula subhimachala*** (Hodgson) (Nepal). Crimson-browed Rosefinch 3: 119.

2: 1 male, 1 female.

Both the birds were collected from Wamrong, East Bhutan in February-March 1966. Both male and female have short bill, the base of which is as broad as the forehead. The reddish rufous tips of the lesser, median and greater coverts form three wingbars. In female, they are less prominent. Outer edges of rectrices and remiges are shiny bright rufous, with a reddish tinge in male, and slightly dull with yellow wash in female. Chin and throat are dark grey, mottled with white; breast grey, mottled with yellow; belly greyish brown, and vent still lighter than the belly in female.

Measurements on p. 366.

2034 ***Haematospiza sipahi*** (Hodgson) (Nepal). Scarlet Finch 5: 117.

15: 9 males, 6 females.

3 Temi, W. Sikkim, 1 Singhik, N. Sikkim, 2 Sikkim, 1 Kurseong, Darjeeling, 1 Honka, West, 2 Batase, Central, 2 Deothang, East, 1 Wamrong, East Bhutan, 2 Abor Country, Sadiya.

Wamrong male collected in March 1966 is the darkest. Specimens collected by C.M. Inglis (1914) and J.M. Falkiner (Abor expedition) are paler scarlet, may be due to fading.

Males have heavier blunt bills, whereas female bills are thinner and sharper. Kurseong male collected by C.M. Inglis in January 1914 is in female plumage but has a heavy blunt bill.

Measurements on p. 366.

2035 ***Pyrrhoplectes epauletta*** (Hodgson) (Northern and Central regions, Nepal). Gold-naped Black Finch 3: 114.

4: 3 males (1 by pl), 1 female.

1 Narphong, 2 Wamrong, E. Bhutan, 1 Ganglipokti, Bhutan.

All the males were collected in February 1966 and the female in November 1973. The unsexed bird from Narphong is the only one with a bright orange-yellow crown, but the whole underpart is sooty black, except for the vent which is ochraceous.

Measurements on p. 366.

2036 ***Pyrrhula nipalensis nipalensis*** Hodgson (Northern and Central regions, Nepal). Nepal Brown Bullfinch 3: 112.

8: 5 males, 3 females.

2 Dakuri, Punjab, 1 Baghi, Bushan St, 1 Naikanda, Kumarsain, NWH, 1 Darjeeling, 1 Chimakothi, W. Bhutan, 2 Shamgong, C. Bhutan.

Female is distinct, a dull version of the male. The scaly pattern of the head is almost absent in the female.

Measurements on p. 366.

2037 ***Pyrrhula nipalensis ricketti*** La Touché (Mountains of northwest Fokien, southeast China). Chinese Brown Bullfinch 3: 113.

Nil.

2038 ***Pyrrhula erythaca erythaca*** Blyth (Sikkim). Beavan's Bullfinch 3: 111.

Nil.

2039 ***Pyrrhula erythrocephala*** Vigors (Himalayan Mountains = Simla-Almora area). Red-headed Bullfinch 3: 110.

51: 39 males, 11 females, 1 unsexed.

1 Keonthal, 1 Chirot Nulla, 4 Koti, 5 Simla, 1 Simla Hills, NWH, 2 Taradevi, 1 Pindari, 2 Kaliaghat, Garhwal, 1 Yumthang, 1 Sikkim, 17 Sandak Phu, Darjeeling, 6 Gomchu, 8 Wamrong, 1 Rongtong, E. Bhutan.

The males differ from those of Orange Bullfinch in having a grey mantle and wingbar, a good contrast from the reddish head; in Orange Bullfinch, the crown is almost concolourous with the mantle. Females have brownish-yellow crown, whereas Orange Bullfinch females have greyish-brown crown and back.

There is appreciable difference in the extent of white on the rump in birds collected from North East and Western Himalayas, which cannot be correlated to the season or sex of the specimens. Birds from Western Himalayas, both male and female collected in February, March, April, June, August and November, have white rump 20 to 32 mm, while those from Eastern Himalayas have a narrow white rump. The Darjeeling specimens collected in August 1905 by C.M. Inglis have 8-15 mm wide white rump, while in the Bhutan specimens collected in March 1966 it is 8-19 mm.

Measurements on p. 366.

2040 ***Pyrrhula aurantiaca*** Gould (Western Himalayas, restricted to Kashmir by Baker 1926, FBI 3: 109). Orange Bullfinch 3: 109.

10: 7 males 2 females, 1 unsexed.

1 Chitral, 1 Gotti, Keyah, 1 Liddar Valley, 4 Rawil Nulla, 1 Liddarwat, 1 Dachigam, Kashmir, 1 Dalhousie, NWH.

The specimens date back from 1879 to 1911 except two collected in 1941 and 1971. The black forehead is broader in this species than in *erythrocephala.*

Measurements on p. 366.

EL ***Pyrrhula pyrrhula*** (Linnaeus) (Sweden). Common Bullfinch.

5: 2 males, 3 females.

All 5 were purchased from Crawford Market in Mumbai and were wrongly identified and placed with *Pyrrhula aurantiaca* and *Pyrrhula nipalensis.*

Measurements on p. 366.

EL ***Pyrrhula pyrrhula rossikowi*** Deryugin *et* Bianchi (Caucasus). Caucasian Bullfinch.

1 male from USSR.

Measurements on p. 366.

EL ***Uragus sibiricus sibiricus*** (Pallas) (Southern Siberia). Long-tailed Rosefinch.

One undated unsexed specimen, male by plumage, collected by Col Thomson from *Kashgar, China*, marked *Carpodacus roseus* is in fact the Long-tailed Rosefinch of east Asia. Single species with many races, may be related to other finches. Bill is very similar to that of Bullfinches denoting a possible affinity to *Pyrrhula.*

Measurements on p. 366.

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BEHAVIOURAL AND FUNCTIONING INTERACTIONS IN THE SCHIZOTHORACID COMMUNITY IN THE RIVER MANDAKINI: AN ASSESSMENT THROUGH ALTERING SEX RATIO PATTERNS[1]

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The interrelationships and functioning of three closely related species, *Schizothorax plagiostomus* Heckel, *Schizothorax richardsonii* Gray and *Schizothoraichthys progastus* McClelland (Teleostei, Family Cyprinidae, Subfamily Schizothoracinae), comprising the snow trout or schizothoracid community, as reflected by the altering sex ratio patterns, have been assessed quantitatively. Observations were made for two years, from January 1991 to December 1992, at four landing sites: Bheri (1,020 m), Chandrapuri (827 m), Agastyamuni (760 m) and Tilwara (724 m), covering the lower stretch of over 30 km of the high altitude glacier-fed River Mandakini in the Garhwal Himalaya. The water characteristics of the river (total water discharge, water velocity and water temperature) were measured at Chandrapuri. The total fish catch of these species from all the sites was first pooled and arranged according to sex, percentage, breeding and non-breeding seasons. The sex ratio was determined. These species breed twice a year, from March to May and August to October, with well-defined non-breeding intervals. These species individually followed a similar pattern of response to changes in the environment, as revealed by the altering sex ratio patterns i.e., highest values during first breeding season of 1991 and 1992 (2.65:1, 3.0:1, 3.89:1 and 2.56:1, 3.86:1, 4.75:1 respectively) when water parameters began rising from the lowest in the extreme winter. The lowest values of sex ratio were observed during the second breeding seasons of 1991 and 1992 (2.03:1, 1.51:1, 1.58:1 and 1.59:1, 1.82:1, 1.74:1 respectively) when water characteristics values were at a peak, or just began plummeting from the peaks of monsoon. The corresponding values of sex ratio in the entire schizothoracid community were observed as 2.78:1, 2.83:1 and 1.91:1, 1.61:1 respectively, during the first and second breeding seasons of 1991, 1992. Sex ratio begins to alter at the commencement of just rising and/or peak, or just plummeting periods. Altering sex ratio pattern is one of the indicators of the beginning of the breeding process. That is the fish take the changes in surroundings as the cue to initiate breeding process. Both the species and the community of schizothoracine fishes alter their sex ratio pattern in response to changes in their surroundings. This pattern can serve as an indicator of the functioning and interrelationship at individual, population, species and community levels. Patterns of sex ratio change must be utilized for assessing the behavioural and evolutionary processes over a period as well as an effective tool in the regulative management of snow trout community in the high altitude glacier-fed hillstreams of Garhwal Himalaya.

Key words: Schizothoracid community, sex ratio, River Mandakini, functioning interactions, behavioural indicators, evolutionary processes

INTRODUCTION

Odum (1971) and Kendeigh (1980) described the conceptual framework of biotic communities. In fluvial systems, unidirectional flow and gradient determine the mobility of the subject. This offers entirely different challenges in the ways of studying the biotic communities therein. The biotic communities in the rapidly flowing hillstreams are heterogeneous assemblage of several plant and animal taxa of diverse features with intricate relationships. The upstream and downstream boundaries of the habitat(s) and movement of the residents for diverse purposes are difficult to determine. In view of these restraints, the behavioural attributes in terms of altering sex ratio patterns of schizothoracid or snowtrout community consisting of *Schizothorax plagiostomus* Heckel, *Schizothorax richardsonii* Gray (both bottom dwellers and feeders, herbivorous) and *Schizothoraichthys progastus* McClelland (column dweller and feeder, carni-omnivorous) are analysed as further extension of earlier works (Bhatt 1993; Singh 1995, 1997; Singh and Subbaraj 2000; Singh *et al.* 1996) focusing on the high altitude glacier-fed hill stream, Mandakini in Garhwal Himalaya.

The sex ratio of fish population is an effective indicator of functioning, behavioural strategies and catch composition (Nikolskii 1980; Engenwaji 1992). In the Indian subcontinent, with immense scope of diversity and potentials of fish fauna, the assessment of functioning and interrelationships through sex ratio and/or similar indices of fishes at population, species and community levels remains unexplored, thus, eliminating their advantageous uses for determining the characteristics, planning and management of cultivable and non-cultivable fishes to any worthwhile level (Pantulu 1961; Bhatt 1993; Nautiyal 1994).

The dominant status, economic potentials yet hitherto little explored avenues of schizothoracid community, in the entire Himalayan region, in general, and in Garhwal hills in particular, offer enough incentives for assessing the functioning interrelationships, their observable indices (sex ratio change being one of these), and response(s) to the milieu of changing surroundings of glacier-fed hillstreams in the region like River Mandakini.

MATERIAL AND METHODS

The study is based on the analysis of the total fish catch of *Schizothorax plagiostomus*, *Schizothorax richardsonii* and *Schizothoraichthys progastus* in the lower stretch of over 30 km of glacier-fed high altitude River Mandakini, which finally meets with the still larger River Alaknanda at Rudraprayag (*JBNHS 94(2)*, 1997: Fig. 1, p. 418). The random sampling of adult specimens was made at four landing sites — Bheri (1,020 m), Chandrapuri (827 m), Agustmuni (760 m), and Tilwara (724 m). Since all these three species breed twice a year, from March-May and August-October, the data were analysed and computed on the basis of a pooled number as sample size, percentage of males and females in the total catch, breeding and non-breeding seasons with respect to individual species separately. The ratio of M:F (M - number of males, F - number of females) during the corresponding seasons gave the sex ratio of each species.

The data of water parameters of River Mandakini — total water discharge (m^3/sec), water velocity (m/sec) and water temperature (°C) — during the corresponding study period have been obtained from the Uttar Pradesh Irrigation Department, Srinagar Garhwal as measured at Chandrapuri (*JBNHS 94(2)*, 1997: Fig. 1, p. 418), and were converted into mean monthly values of respective seasons.

RESULTS

Sample size: The study is based on analysis of a total of 5,587 adult specimens. Examination of the total fish catch from all the four landing sites when pooled together revealed evident variations. The highest representation of *Schizothorax plagiostomus* [total 4,585 (82.07%), males 3,120 (81.95%), females 1,465 (82.30%)] placed this species on the top status not only in the schizothoracid community, but also among all the fish species resident in River Mandakini. *Schizothorax richardsonii* also had a good representation [total 674(12.06%), males 455(11.96%), females 219(12.30%)] but *Schizothoraichthys progastus* happened to be poorly represented [total 328(5.87%), males 232(6.09%), females 96(5.39%)] (Fig. 1). Despite this enormous variation in sample size, the percentage of males and females during the corresponding period suitably conformed to the respective structural representation in the community (Fig. 2). Further, the sample size did not cast its shadow on the overall response(s) patterns.

Percentage of males and females: The analysis of fish catch in terms of sex percentage of two years offered similarity of patterns which the three species exhibited respectively (Table 1, Fig. 1). For the entire community, the corresponding values of percentage of males were 9.31, 13.12 and 12.83, 14.39 respectively during the first and second breeding season of 1991 and 1992. For females the percentages were found to be 3.35, 6.87 and 4.53, 8.93 respectively during the corresponding breeding and non-breeding seasons of 1991 and 1992 (Fig. 2).

Sex ratio: It is an effective and definite indicator of response(s) and interactions within the community as well as to the changing surroundings. The analysis samples of *Schizothorax plagiostomus*, *Schizothorax richardsonii* and *Schizothoraichthys progastus* revealed a consistent pattern of sex ratio alterations (Table 2, Fig. 1). All three species showed higher sex ratio (2.78:1, 2.83:1 respectively) during the first breeding season of the year but lower figures (1.91:1, 1.61:1 respectively) during second breeding of the year (Fig. 2).

Water parameters of the River Mandakini (Figs 1, 2): The habitat of the three species of schizothoracid community in the River Mandakini, when analysed and quantified for total water discharge, water velocity and water temperature, presented an overview conforming to the overall picture of what had been stated so far. The mean monthly values of river characteristics began rising from March-May 1991, 1992 from the lowest figures during extreme winters and remained moderate — total water discharge (36.96, 88.32 m^3/sec), water velocity (0.745, 0.686 m/sec) and water temperature (11.05, 11.61 °C) — when males in the community comprised the highest representation. Conversely, during the second breeding season in August- September, October 1991, 1992 these parameters were either at the peak or had just started coming down from the peak values of monsoon; i.e., 155.34, 170.63 m^3/sec; 1.805, 1.919 m/sec and 15.05°, 15.8 °C respectively when the sex ratio touched the corresponding lowest values. Thus, the water parameters of the River Mandakini perfectly simulate and stimulate the picture of the community response(s) as a whole when viewed along with the corresponding data.

DISCUSSION

(a) Major structural features such as dominant species like forms or indicators, and (b) physical habitat of the community and functional attributes such as type of

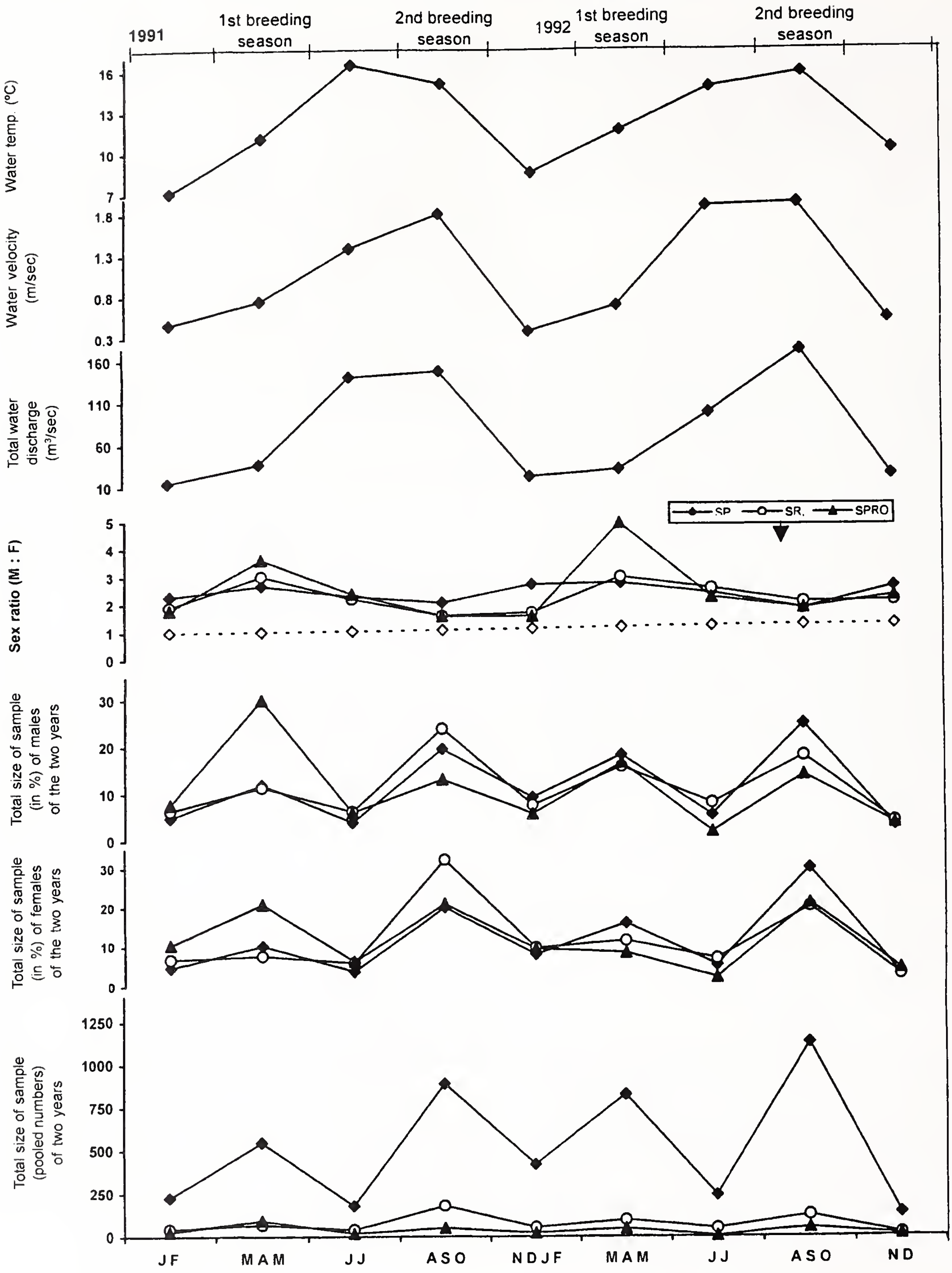

Fig. 1: Sex ratio of *Schizothorax plagiostomus* (SP), *Schizothorax richardsonii* (SR) and *Schizothoraichthys progastus* (SPRO) in relation to sample size, percentage of females and males and water parameters (total discharge, velocity & temp.) during breeding and non breeding seasons of 1991-1992 in the river Mandakini

community, metabolism etc. are a convenient basis for naming and classifying the community (Odum 1971). Of these, functional approaches offer better alternatives for comparison of all communities in widely different habitats. Regarding the fish communities within the geographical regions, the major approaches must include - (1) Zonal approach for recognizing, classifying and listing in a sort of check-list of community type, (2) gradient analysis approach involving the arrangement of population along uni- or multi-dimensional environmental gradient axis with community recognition based on statistical comparison. Also, there are certain specifically interesting questions about fish communities - (i) To what extent can fish in similar habitat be predicted? (ii) How are fish communities organized? Does the last member of the sensitive species result in the collapse or irreversible changes in the community? (iii) How is the state of development or completeness measured, and hence assessment of the extent to which it has been degraded by environmental change(s). Notable examples of such studies of temperate fish communities of North America include those by Harvey, 1975, 1978; Johnson *et al.* 1977; Tonn and Magnuson 1983.

The analytical studies of fish communities in the Indian context are not addressed to in right perspectives despite the sizable scope of diversity, functional changes within shorter time and space (Shastri *et al.* 1982), potentials of newer distinct approaches likely to emerge. In Garhwal region, Kumar (1991) analysed microzoobenthic communities of River Alaknanda, and Rawat (1992) undertook the analysis of community structure of plankton in high altitude Lake Deoria Tal.

The functional approach of community analysis of Indian fishes in diverse fluvial systems wherein the subject as well as physical habitat have high mobility and, hence, the community functioning and interactions are at continuous change — are rather obscure obviously due to low feasibility. However, Bhatt and Pathak (1992) have explained a few species at community level.

From quantitative and qualitative estimates of present study, the topmost status of schizothoracid community is evident among various animal communities inclusive of those of other fish communities resident in River Mandakini. Based on dominance, various species of schizothoracid community may be arranged, from higher to lower ranks, as (1) *Schizothorax plagiostomus*, (2) *Schizothorax richardsonii*, (3) *Schizothoraichthys progastus* (Singh *et al.* 1996) and so on. The variation in the quantitative values of different functional attributes (including sex ratio, breeding seasons) at different sites is due to the continuum of complex dynamics, altering interactions of individuals-individuals, individual-population, population-population, population-species, species-species, species-community, community-community and also with surroundings in each case and at each level apart from working modalities.

The highest absolute numbers of specimens during breeding seasons, especially at Chandrapuri and Tilwara (*JBNHS 94(2)*, 1997: Fig. 1, p. 418, where smaller rivulets debouch into river Mandakini), percentage of males and females in the total catch during March, April, May 1991, 1992 and then during August, September, October, 1991, 1992 respectively, are convincing proof of these species breeding twice a year (see Singh 1997). At the onset of breeding, potential male and female brooders migrate from lower stretches of larger glacier fed hill streams (like Ganga, Alaknanda etc.) to the upper reaches of their tributaries. Small glacier / non-glacier fed streams or rivulets with faster water velocity, lesser turbidity etc. are more conducive environs for brooders, spawn and juveniles. Destinations like Chandrapuri and Tilwara (sites of confluence) are more preferred sites for spawning and breeding purpose.

Singh (1997) mentioned several intrinsic and extrinsic factors interacting together and collectively responsible for

Table 1: Profile of pecentage of males and females of three species of schizothoracid community during breeding and non-breeding seasons of 1991-1992 in the River Mandakini

Species	Sex	November-February (1st Non-breeding)				March-May (1st breeding)		June-July (2nd Non-breeding)		August-October (2nd breeding)	
		Jan-Feb 1991	Nov-Dec 1991	Jan-Feb 1992	Nov-Dec 1992	1991	1992	1991	1992	1991	1992
Sp. 1	Male	5.03	9.68		3.01	12.72	19.07	3.09	5.26	19.10	22.18
Sp. 2	Male	6.37	7.25		2.42	11.21	17.80	6.15	7.69	23.52	17.58
Sp. 3	Male	7.76	5.60		3.45	31.89	16.38	6.03	1.72	12.93	14.22
Sp. 1	Female	4.70	7.92		2.73	10.24	15.77	3.75	5.19	20.00	29.69
Sp. 2	Female	6.85	7.76		2.74	7.76	9.59	5.94	6.85	32.42	20.09
Sp. 3	Female	10.42	9.38		4.16	19.79	8.33	6.25	2.08	19.79	19.79

Sp. 1 = *Schizothorax plagiostomus*, Sp. 2 = *Schizothorax richardsonii*, Sp. 3 = *Schizothoraichthys progastus*

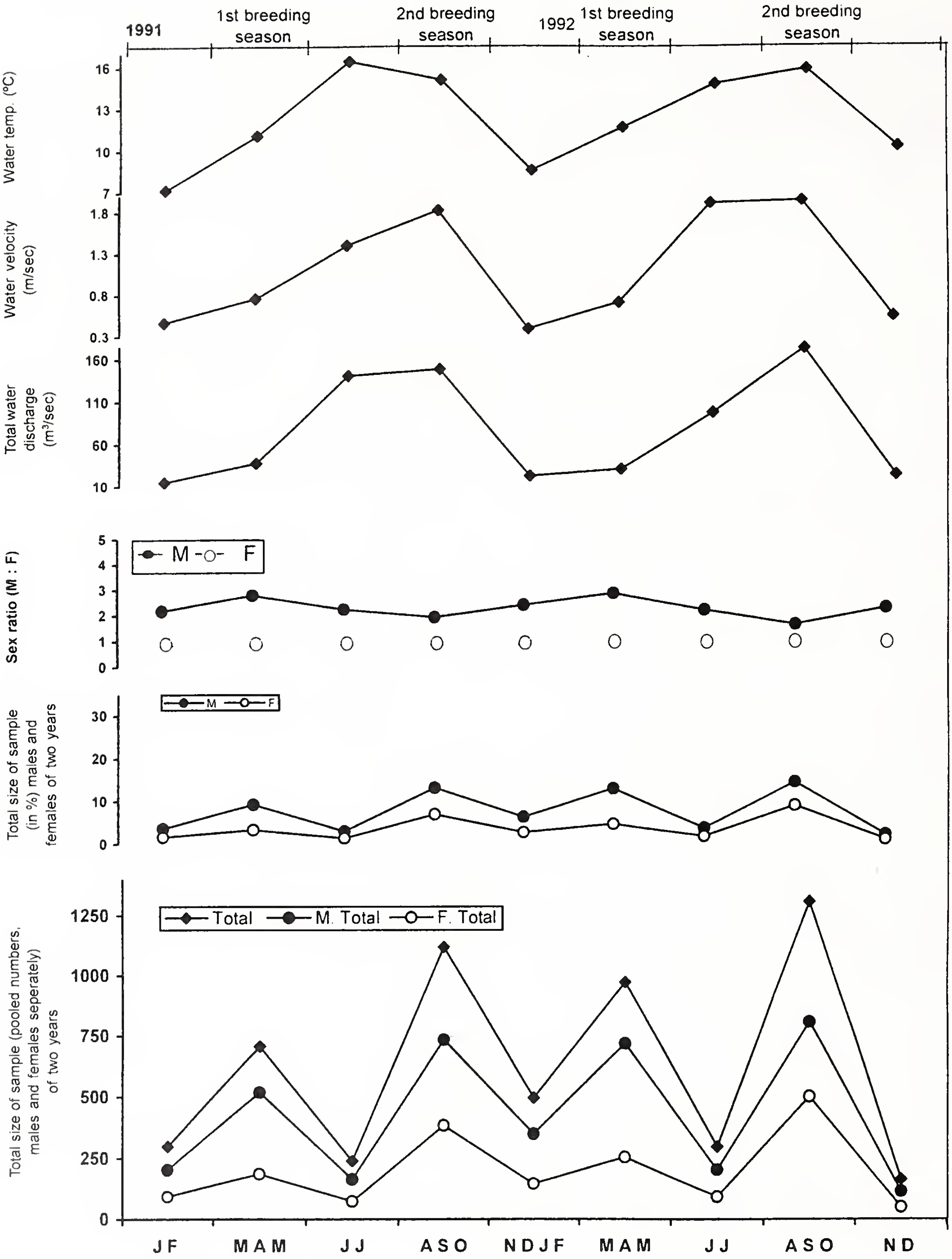

Fig. 2: Sex ratio of Schizothoracid community in relation to pooled numbers as well as males and females separately, % of females & males and water parameters (total discharge, velocity & temp.) during breeding and non-breeding seasons of 1991-1992 in the River Mandakini (Compare with Fig. 1)

Table 2: Profile of the sex ratios of three species of schizothoracid community during breeding and non-breeding seasons of 1991-1992 in the River Mandakini

Species	November-February (1st Non-breeding)				March-May (1st breeding)		June-July (2nd Non-breeding)		August-October (2nd breeding)	
	Jan-Feb 1991	Nov-Dec 1991	Jan-Feb 1992	Nov-Dec 1992	1991	1992	1991	1992	1991	1992
Sp. 1	2.28:1	2.60:1		2.35:1	2.65:1	2.56:1	2.24:1	2.16:1	2.03:1	1.59:1
Sp. 2	1.93:1	1.94:1		1.83:1	3.00:1	3.86:1	2.16:1	2.33:1	1.51:1	1.82:1
Sp. 3	1.80:1	3.67:1		2.00:1	3.89:1	4.75:1	2.33:1	2.00:1	1.58:1	1.74:1
Schizothoracid Community	2.17:1	2.38:1		2.26:1	2.82:1	2.79:1	2.23:1	2.18:1	1.91:1	1.61:1

Sp. 1 = *Schizothorax plagiostomus*, Sp. 2 = *Schizothorax richardsonii*, Sp. 3 = *Schizothoraichthys progastus*

higher male sex ratio during the first breeding season of the year: (i) earlier departure of males and late arrival of females, (ii) fresh recruitment of new batches of subadults into brooders, (iii) difficulties encountered by female brooders during upstream migration because of their full-grown belly and relatively lower water discharge to cope with the larger sized females. The conditions otherwise are conducive for spawning and breeding resulting from moderate conditions, and (iv) vulnerabilities of female brooders to their predators and other natural hazards. Also, environmental conditions during the first breeding season favour the male, whereas females are favoured during the second breeding period of the year. Another possibility of sex ratio alterations may be sex dependent mortality and intersexes in population (an entirely new dimension).

Since the present assessment is based on the data of three closely related species of schizothoracids, it indicates a similar picture of response(s) as evident from sex ratio variations in relation to changing river characteristics. This similarity lends further credence to their close genetic kinship as they inhabit and share common habitat (the river Mandakini and likes in the Himalayan region) and also encounter similar challenges and opportunities, use similar cues and stimulants. Obviously, they must have evolved similar behavioural repertoire, functioning strategies and response(s) at individual, population, species and community levels. Varying sex ratio patterns, mobilization of spawning grounds (Singh 1995) are among these. Such behavioural responses of the community also include the interplay of intra- and inter-specific convergence, divergence/diversity, which are at the helms of evolutionary processes. Sex ratio alterations also reflect the pattern diversity of stratification (Pielou 1966), zonation, activity, reproduction, social, co-action, stochasticism etc. However, many significant questions emanate out of such a scenario, namely levels of intra- and inter-specific convergence and divergence/diversity while inhabiting similar habitat and using similar cues for spawning, breeding and other vital processes? Here lie the possibilities of preponement and/or postponement of such changes in behavioural indices and indicators (like sex ratio alterations) by a few hours/days enough for such resource mobilization, resource partitioning and minimizing the competition for resources at successive levels within the community which must have been too intense. It is also indicative of intelligent designing of behavioural strategies of schizothoracids in nature for mobilization of transitional but moderate resources in terms of timing and space for breeding.

This analysis of altering sex ratio patterns in *Schizothorax plagiostomus*, *Schizothorax richardsonii* and *Schizothoraichthys progastus* presents an overall picture in the River Mandakini in particular and other glacier-fed hillstreams of Garhwal region in general. This study of schizothoracid community, though raising several questions to be answered from various points of view, should be utilized in two ways; first, in revealing the processes of signalling of individual-population-species-community responses, convergence-divergence at behavioural, physiological and environmental levels, and second, in regulative management of schizothoracid fishery in glacier-fed high aititude hillstreams of Garhwal region.

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STATUS OF SEA-COW *DUGONG DUGON* (MÜLLER) ALONG THE SOUTHEAST COAST OF INDIA[1]

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Observations on the stranding and incidental catch of Sea-cow *Dugong dugon* (Müller) along the southeast coast of India are reviewed here. The number of incidental catch and stranded Dugongs were greater in the Gulf of Mannar than in the Palk Bay region during 1994-2000. The need for protection and conservation of Dugongs from indiscriminate exploitation are stressed upon to evolve suitable management strategies.

Key words: *Dugong dugon*, distribution, stranding, incidental catch, conservation

INTRODUCTION

The Dugong *Dugong dugon* (Müller), popularly known as Sea-cow, is a marine mammal, which enjoys a wide distribution in the Indo-Pacific region from the east coast of Africa and Red Sea to Australia. In India, it occurs in the southeast coast in the Gulf of Mannar and Palk Bay, on the Saurashtra coast and in the Andaman Sea of South and Middle Andamans.

In the 18th Century, naturalists like Müller, Lacepede and Erxleben reported the occurrence of Dugong in different parts of the Indian Ocean. In the early 20th Century, Annandale (1905, 1907) and Thomas (1966) gave an account of the identity, external features, habits and osteology of the Indian Dugongs. Jones (1959, 1967a, 1967b), and Nair and Lal Mohan (1975) dealt with the distribution, abundance, habits and food, giving a lot of information on a pair of captive Dugongs in the aquarium of the Central Marine Fisheries Research Institute at Mandapam Camp. Jones (1966) pointed out the need for protection and conservation of Dugongs from indiscriminate exploitation. Mani (1960) and Silas (1961) reported the occurrence of Dugongs on the Saurashtra coast. Lal Mohan (1963, 1980) reported their occurrence in the Gulf of Kutch and described the major fishing grounds, seasonal occurrence, size distribution, sex ratio and breeding habits of Dugongs for 1971-1975 from Palk Bay and Gulf of Mannar. James (1979) made an osteological study of Dugongs. James (1985), James and Lal Mohan (1987) and Lal Mohan (2000) stressed the need for the conservation of marine mammals with particular reference to the Sea-cow.

Recently, Krishnapillai *et al.* (1989) studied the internal organs of Sea-cow; Krishnapillai *et al.* (1991) reported incidental catch of Dugongs; Victor *et al.* (1999), Bose and Gandhi (1999), and Balasubramanian and Easterson (2000) have reported stranded Dugongs from the Mandapam waters. The Wildlife Warden of Gulf of Mannar Marine National Park, Ramanathapuram periodically observed stranded Dugongs (*pers. comm.*).

Designated as a National Biosphere Reserve, the Gulf of Mannar and its 3,600 species of flora and fauna is one of the biologically richest coastal regions of India. It is equally rich in sea weeds, algae, sea grass, coral reefs, pearl banks, sacred chank beds shellfish resources, mangroves and the endemic and endangered marine mammal — Dugong.

The first author made personal observations, as well as extensive enquiries with fishermen on stranded Dugong along the Gulf of Mannar and Palk Bay coasts during 1994-1998, the details of which are presented in this paper. The present study may throw more light on the need for conservation of these endangered species along the Indian Coasts.

METHODS

Dugongs entangled in incidental catches and stranded in the Gulf of Mannar and Palk Bay regions were considered for the studies. Details of sex, length, weight and other morphometric characters were noted.

Distribution

Dugongs are widely distributed in the tropical Indo-Pacific region. According to Macmillan (1955), they are distributed from East Africa, Madagascar, Red Sea, India, Ceylon (= Sri Lanka), Malaya, Philippine Island, Australia, New Guinea to Marshall Islands.

Prater (1928), Petit (1924, 1927a, b, c), Bertram and Bertram (1964, 1968) and Bertram and Colin (1964) have studied various aspects of the Dugong. In Indian waters, Jones (1959,

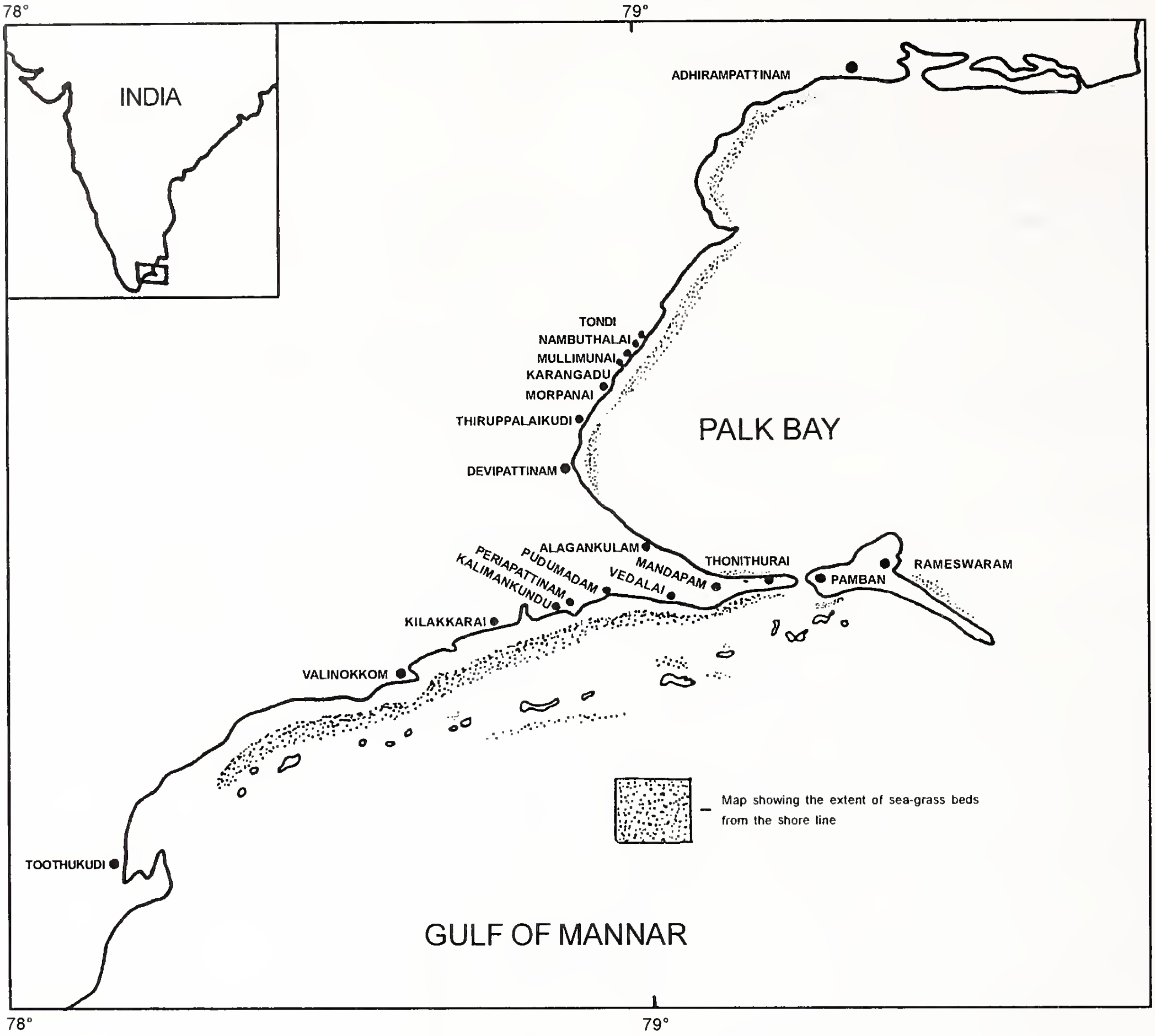
78°
79°
INDIA
ADHIRAMPATTINAM
TONDI
NAMBUTHALAI
MULLIMUNAI
KARANGADU
MORPANAI
THIRUPPALAIKUDI
DEVIPATTINAM
PALK BAY
ALAGANKULAM
PUDUMADAM
PERIAPATTINAM
KALIMANKUNDU
MANDAPAM
VEDALAI
THONITHURAI
PAMBAN
RAMESWARAM
KILAKKARAI
VALINOKKOM
TOOTHUKUDI
Map showing the extent of sea-grass beds from the shore line
GULF OF MANNAR
78°
79°

Fig. 1: Map showing the incidental catch / stranding centres of Sea-cow and extent of sea-grass bed in the Gulf of Mannar and Palk Bay

1966, 1967a, b) and Lal Mohan (1963) recorded stranding of Dugong and gave detailed information of skeletons.

In Palk Bay, occurrences of Dugongs were reported at Rameswaram Bay, Olaikuda, Devipattinam, Thondi, Sundarapandianpattinam and Adirampattinam.

Food and feeding habits

Dugong is a herbivorous feeder on sea grasses found in abundance in the shallow regions of coastal waters. The stomach contents of Dugongs captured in the Gulf of Mannar and Palk Bay near Mandapam were found to contain the sea grass *Cymodacea serrulata*, *C. isoetifolia*, *Halodule uninervis*, *Halophila ovalis* and *Enhalus acoroides*. *Cymodacea serrulata* was the main food item, while *Halophila ovalis*, and *Halodule uninervis* formed a minor food item of the Dugong in Mandapam (Nair *et al.* 1975).

Age and growth

The only available references on longevity are those of Dugongs reared in captivity at Mandapam Camp for 11 years. However, the longevity of Dugong has been reported to be about twenty years (Nair *et al.* 1975).

Reproduction

The female Dugong gives birth to one young at a time. Jones (1959) recorded a free-living young Dugong with a total length of 95 cm from Mandapam. The CMFRI Museum at the Mandapam Camp has a 113 cm long stuffed young dugong. A 302 cm long dugong stranded near Kilakkarai on December 11, 1995 was found to have a foetus, which measured 150 cm in length and 40 kg in weight (Table 2).

Observations were made on the growth of two dugongs reared in captivity in the Marine Aquarium at the CMFRI, Mandapam Camp during 1959-1970. Two males, 160 cm and 196 cm long, were 207 cm and 226 cm respectively at the time of their death. The first individual grew 47 cm long with an average growth rate of 4.3 cm per year, while the second grew by 30 cm with an average growth rate of 2.8 cm per year in an eleven year period. The growth of the first Dugong was faster than the second one because it was younger (Nair *et al.* 1975). The captive Dugongs were not weighed when alive, hence there is no information on the rate of increase in weight.

Fishing

In earlier years, in the Gulf of Mannar, Dugongs were caught mostly in turtle nets, dugong nets, and shore-seines. Turtle net is a gill-net made of twisted cotton twine or twisted *Acacia* fibre with a mesh size of 10-15 cm. Dugong net is a bottom set gill-net made of cotton or nylon twine, with mesh size of 15-18 cm. These nets were not in use after the promulgation of the Indian Wildlife (Protection) Act, 1972. Occasionally, dugongs get entangled in 'Thirukai Valai', a gill net with large meshes exclusively used for catching rays.

OBSERVATIONS

In the present study, information on stranding and incidental catch of Dugongs in Palk Bay and Gulf of Mannar was collected by direct observation and enquiry with fishermen as well as from local newspapers. These investigations revealed that 25 Dugongs were stranded or

Table 1: Morphometric measurements (in cm) of Dugongs recorded in Indian waters

Morphometric measurements	1	2	3	4	5	6	7	8	9	10
Date of reporting	-	-	-	16.12.86	20.3.98	30.4.98	-	28.3.99	-	23.3.59
Total length	240	242	226	310	245	281	268	162	113	95
Forkal length	-	-	-	-	-	265	252	-	110	93
Length of muzzle	14.8	14.5	24.8	-	18	18	22	-	9.5	7
Breadth of muzzle	21.0	24.5	22.0	-	24	24	26	-	5	5
Length of chin	11	14	14.3	-	-	12	-	-	-	-
Breadth of chin	12.5	17.5	14.5	-	-	18	-	-	-	-
Length of flipper	41	43.5	34.5	54	35	40	31	27	14.5	19.3
Breadth of flipper	-	-	11.5	-	-	18	-	-	-	-
Circumference of belly	174	156.5	150.2	-	164	-	120	-	97	58
Distance between submental sulcus and genital orifice	995	124.5	115	-	-	-	-	-	-	-
Length of genital orifice	-	-	8.8	-	-	-	-	-	-	-
Distance between genital orifice and anus	31.7	-	10	-	33	-	-	-	-	-
Breadth of tail fluke	70	80.5	62.6	-	-	-	-	-	-	-
Distance between snout to anus	-	-	270	160	-	-	-	-	-	-
Snout to origin of genital opening	-	-	-	160	121	-	-	-	-	-
Snout to flipper	-	-	-	60	-	-	-	-	-	-
Distance between flippers	-	-	-	59	-	-	-	-	-	-
Snout to eye	-	-	-	58	-	-	26	14.5	9	9
Distance between eyes	-	-	-	58	-	-	-	-	-	15.2
Snout to nostrils	-	-	-	18	-	13	-	-	8	8
Girth at neck (Origin of flipper)	-	-	-	-	-	-	-	-	-	-
Girth at genital opening	-	-	-	200	-	-	-	-	-	-
Girth at anus	-	-	-	135	-	-	-	-	-	-
Circumference in origin of flipper	-	-	-	180	-	-	-	-	-	52
Sex	Male	Female	Female	Male	Male	Male	Male	Male	-	-
Wt (in kilograms)				400	200	210	-	180		
Remarks										

Baby Dugong stuffed and preserved

Table 2: Incidental catch and stranding of Sea-cow in the Gulf of Mannar

S. No.	Date	Place of capture and stranding	Method of capture	Approximate		Sex	Source of information Remarks
				Length (cm)	Weight (kg)		
1.	23.03.1955	-	-	95	-	-	Reported by CMFRI Staff
2.	14.06.1955	-	-	212	-	-	"
3.	26.12.1956	-	-	150	-	Female	"
4.	02.10.1959	-	-	160	-	Male	"
5.	06.12.1959	-	-	196	-	Male	"
6.	"	-	-	240	-	Male	"
7.	"	-	-	242	-	Female	"
8.	"	-	-	226	-	Female	"
9.	16.12.1986	-	-	310	400	Male	"
10.	14.12.1994	Periapattinam	Died due to shock from dynamiting	-	300	-	Reported by fishermen, sold at shore
11.	02.06.1995	Pudumadam	Caught in shore seine	-	250	Female	"
12.	17.06.1995	Appa Island	"	-	80	Female	"
13.	30.10.1995	Periapattinam	"	-	60	Female	"
14.	25.11.1995	Kilakkarai	Not known	-	75	Female	"
15.	11.12.1995	Kilakkarai	Washed ashore	302	500	Female	Reported by Wildlife Warden Ramanathapuram
16.	21.12.1995	Mundal (Valinokkam)	Washed ashore in semi-decomposed condition	-	400	-	Informed by CMFRI staff
17.	10.01.1996	Kannirajapuram	Not known	-	120	-	Brought to Periapattinam and sold
18.	14.03.1996	Valinokkam	Washed ashore	-	200	-	Inspected by Wildlife Warden and buried
19.	14.06.1996	Periapattinam	Not known	-	45	-	Sold at shore
20.	20.06.1996	Kalimankundu	Shore seine	-	25	-	"
21.	05.08.1996	Periapattinam	Shore seine	-	70	-	"
22.	07.09.1996	Rameswaram	Not known	-	100	-	"
23.	11.01.1997	Seeniappa Darha	Thirukkai Valai (net)	-	60	-	"
24.	12.01.1997	Valinokkam	Not known	-	-	-	Sold at shore, flesh confiscated by official, seller fined Rs. 3000/-
25.	14.01.1997	Kilakkarai	Mayavalai (net)	-	-	-	Sold at shore
26.	15.01.1997	Seeniappa Darha	Thirukkai Valai (net)	-	160	-	"
27.	26.01.1997	Kilakkarai	Shore seine	-	60	Female	"
28.	10.02.1997	Valinokkam	Dead washed ashore, body with shark bite	240	280	-	Inspected by NPM office also and buried
29.	08.09.1997	Muthupettai	Bottom set gill net	-	35	-	"
30.	03.11.1997	Periapattinam	Thirukkai Valai	-	74	Male	"
31.	07.12.1997	Seeniappa Darha	Thirukkai Valai	-	30	-	"
32.	10.12.1997	Seeniappa Darha	Thirukkai Valai	-	35	-	"
33.	02.02.1998	Periapattinam	Caught in gill net	-	120	-	Sold at shore
34.	20.03.1998	Alagankulam	Found dead in the sea no-injuries	45	200	Male	Inspected by Wildlife Warden, buried
35.	30.04.1998	CMFRI Jetty	Washed ashore with propeller injuries, partially damaged	281	210	Male	Buried
36.	28.03.1999	Mandapam (Gulf of Mannar)	Washed ashore	162	803	Male	Semi decomposed condition; buried.
37.	14.01.2000	Tharuvaikulam	Caught in drift gill net	121	30	Male	Informed by CMFRI Staff

caught in fishing nets. Tables 1-3 give the number of Dugongs caught during 1994-98. Out of 25 Dugongs, three were stranded at Kilakkarai and two at Valinokkam in the Gulf of Mannar region.

A total of four dugongs were caught in Palk Bay region, out of which two were stranded, one at Alagankulam and another at Morpannai (found in decomposed condition), and two were caught in gill nets, one at Jegathapattinam and another at Alagankulam (Table 3). In most cases, only sex and approximate weight of the animals could be estimated.

More Dugongs were stranded in the Gulf of Mannar than in Palk Bay region. This may be due to extensive sea grass beds distributed from Rameswaram to Pamban near the sea shore, as well as in and around the islands of Gulf of Mannar at depths up to 5 m. It also forms a congenial habitat for breeding and feeding, including the Gulf of Kutch region.

Incidental catch

In the Palk Bay region, Dugongs were captured at Tondi and Thirupalaikudi, Karankadu, Nambuthalai, Mullimunai and Morpannai (Fig. 1). The catches were either locally consumed or transported to Kilakkarai or Tondi. In the Gulf of Mannar, the chain of islands comprising Hare Island, Talayari Island, Valai Island, Appa Island, Valiamunai Island, and Anaipar Island, and particularly near Sethukkari are potential grounds for occurrence of Dugongs.

The data showed that the majority of Dugongs were caught as incidental catches near shore waters of Valinokkam, Kilakkarai, Kalimankundu, Periapattinam, Seeniappadarha, Vedalai and Thonithurai in the Gulf of Mannar (Table 2). Fishermen also reported that the sightings of Dugongs are very common between Thonithurai and Periapattinam.

The incidental catch and stranding of Dugongs were also observed from Alagankulam and Jegathapattinam, and stranding at Morpannai and Alagankulam in the Palk Bay (Table 3).

The net called "Avolia Valai" which was once used in the Gulf of Mannar and Palk Bay is not in operation due to the effective watch and frequent inspection of the staff of the Marine National Park. For dugongs entangled in this net, death is immediate due to struggle to escape. Dugongs caught in shore-seines were found alive and released in the sea. Most Dugongs caught dead were disposed of secretly. The price of the meat ranged from Rs. 35 to Rs. 50 per kg and the skeletal parts were buried.

Most of the Dugongs captured in the Gulf of Mannar and Palk Bay were between 170 and 280 cm long, according to Nair *et al.* (1975). The largest individual of 406 cm length was reported from Saurashtra coast, but the accuracy of the measurements is doubtful (Silas 1961).

Turner (1894) described a captive dugong foetus measuring 1 to 1.5 m in length. Jones (1959) recorded a 95 cm long juvenile kept alive in an aquarium and stuffed in the CMFRI Museum at Mandapam camp after its death; an *c.*110 cm long juvenile caught in a bottom set gill-net on September 8, 1955 at Adirampattinam and 150 cm long juvenile collected on December 26, 1956 reared in the marine fish pond that lived for 4 months. Recently, a Dugong stranded near Kilakkarai was found with a foetus of about 150 cm. From the above observations, it is clear that a young Dugong at birth may be 95 to 150 cm long and weigh *c.* 20 kg.

Stranding

Stranding of Dugongs was rare. Most animals landed in decomposed condition and the nature of the wound could not be established. One Dugong stranded at Alagankulam on March 20, 1998 had no injury, but a dugong stranded at the CMFRI jetty on April 30, 1998 had a cut made by the propeller of a mechanised trawler in near shore waters (Victor *et al.* 1999). One dugong landed on the Gulf of Mannar side of Mandapam on March 28, 1999 in semi-decomposed condition.

Table 3: Incidental catch and strandings of Dugongs in the Palk Bay

S. No.	Date	Place of capture and stranding	Method of capture	Approximate Length (cm)	Approximate Weight (kg)	Sex	Source of information and remarks
1.	16.02.1995	Jegathapattinam	Gill net	-	150	-	Reported by fishermen, brought to Periapattinam and sold at sea shore
2.	11.10.1997	Morpannai	Washed ashore in decomposed condition	-	-	Male	Informed by FRAD staff, buried
3.	20.03.1998	Alagankulam	Found dead, brought ashore by fishermen	245	200	Male	Inspected by CMFRI staff and Wildlife Warden and buried
4.	02.07.1998	Alagankulam	Caught in gill net, died	-	60	Male	Reported by fishermen, was cut and sold at sea shore

There were some reports of stranded Dugongs with no injuries.

Dynamite fishing is another cause of the death of Dugongs in this area. Explosives are usually used for fish shoals, but they affect nearby dugongs, which mostly die due to shock. On December 14, 1994 a Dugong was found dead after use of dynamite for fishing. Krishnapillai *et al.* (1989) reported killing of Dugong by dynamite at Mandapam.

Conservation and Management

Annandale (1905) has reported non-availability of more than one dugong at a time in the Gulf of Mannar. Many hundreds were reported in the area earlier. Jones (1967b) has stated that there has been a considerable fall in the Dugong population, and he also cited fishermen reporting that a large number of Dugongs were found dead and that thereafter they have become rare. Fishermen also attributed the mortality of dugongs to scarcity of sea grass beds which perished after flooding of rain water. Silas and Fernando (1985) stressed the need for conservation of Dugongs and proposed several conservation and management strategies. Lal Mohan (1991), Silas *et al.* (1985) and James (1985) stressed upon the need for the effective conservation of dugongs, marine mammals and other marine animals, proposing several conservation programmes and the formation of a National Marine Park in the Gulf of Mannar.

There is global concern for the protection of the Dugong, and in India today the residual population of this species in the Gulf of Mannar and Palk Bay is the most vulnerable and facing extinction. Dugongs are not prolific breeders. Moreover, the destruction of grazing beds has confined the animals to a restricted belt of sea grass. Earlier reports as well as the recent stranding and incidental catches, prescribe the need for intensified efforts to conserve marine mammals, particularly Dugongs.

Indian Ocean Alliance Conference held in the Seychelles in 1981 recommended that priority be given to Dugong survey in the Indian Ocean, with the aim of monitoring and protecting local populations and consider the feasibility of re-establishment.

The IUCN Commission of National Park and World Wide Fund (WWF) identified the Reserve as being an area of "Particular concern" due to its diversity and special multiple-use management status. In addition, Gulf of Mannar, as the first marine biosphere reserve declared in India, has long been a national priority.

The Government of India and state of Tamil Nadu jointly set up the Gulf of Mannar Marine Biosphere Reserve (GOMMBRE) on February 18, 1989. The Government of Tamil Nadu in the GOMs. No. 962 dated September 10, 1986 notified under section 35(1) of the Wildlife (Protection) Act 1972 its intention to declare the 21 islands as Marine National Park for the purpose of protecting marine wildlife and its environment, including 3.5 fathoms depth on bayside to 5 fathoms depth on the seaward side.

The Gulf of Mannar Marine National Park is managed by the wildlife wardens of Ramanathapuram, Mandapam, Kilakkarai and Tuticorin, who are provided with an effective wireless communication network and boats for inspection and patrolling.

Action plan

Effective steps are required towards conservation and management of marine mammals, particularly the Dugongs in the Gulf of Mannar and Palk Bay, and an action plan is urgently needed.

1. Staff strength of Gulf of Mannar National Park under Wildlife Warden needs to be increased. Frequent visits should be made to the villages where illegal fishing and cutting of Dugong is done. Intensive watch has to be made near the shore to stop setting of nets in the sea grass beds.
2. Action needs to be taken to create greater awareness and interest in Dugongs and a detailed study of the habits, habitats and behaviour needs to be carried out.
3. Scientific data, such as length, weight, stomach contents should be updated.
4. Mechanized trawlers should be stopped within 5 km from the shore where there is extensive growth of sea grass.
5. Fishing zones and sanctuaries must be established to protect the fauna.
6. Illegal fishing using dynamite must be stopped and laws enacted to curb it.
7. Public awareness has to be created, especially in the fishing villages. The village Panchayat can play a major role in creating awareness. Warnings have to be issued through posters and other publicity systems proclaiming severe punishment for catching and cutting up Dugongs.

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BEHAVIOURAL STRATEGY OF RETURNING FORAGERS OF THE ARBOREAL ANT *OECOPHYLLA SMARAGDINA* (FABRICIUS) DURING THE MONSOON[1]

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Field observations during the southwest monsoon showed that returning foragers of the arboreal ant *Oecophylla smaragdina* adopt a unique behavioural strategy to ensure stability and a firm grip on rain-washed, slippery tree trunks, and also to facilitate movement on the vertical surface of the nesting tree trunks during heavy rain. Within five minutes of a heavy shower, returning worker ants climbing the tree trunk assume a head downward position with their legs fully stretched out, and start aggregating into small clusters of 2-10 ants. With increase in the duration and intensity of rainfall, the clusters rapidly become more compact and increase to more than 50 ants. Finally, large single clusters of more than 100 ants are formed. Within 10-30 seconds of the rainfall slackening, the ants break away from the clusters rapidly and move up the tree trunk to the leaf nests with their heads oriented upwards. This behavioural strategy is an important adaptation of this tropical, arboreal ant species, enabling it to withstand heavy tropical rain.

Key words: *Oecophylla smaragdina*, monsoon rainfall, arboreal ants, cluster formation, behavioural strategy

INTRODUCTION

Arboreal ants belonging to the genus *Crematogaster* which make carton nests (Musthak Ali 1992), genus *Pseudomyrmex* which nest in the hollow thorns of Acacia (Janzen 1967) and genus *Tetraponera* which live in hollow internodes of bamboo (Klein *et al.* 1993), are widespread in the tropics. The territorial, arboreal ant *Oecophylla smaragdina*, which has mature colonies immense in size with a single queen and over half a million large workers (Hölldobler and Wilson 1995), makes nests of leaves still attached to trees (Hingston 1927). Polydomous nest organisation (several nests in one colony) of *O. smaragdina* has further facilitated the accommodation of large numbers of workers and enabled patrolling of distant parts of its three-dimensional (including tree canopies, tree trunks and the foraging ground) territories. While permanently tree-nesting ant species have solved the problem of living off the ground, some species such as *Paratrechina longicornis* nest in the leaf litter, but frequently shift the nests to trees during monsoon (pers. obs.). Although many arboreal ants, such as *Crematogaster* and *Oecophylla* tend homopterans present on trees and collect the excreted honeydew (Way 1963), the worker ants forage mainly on the ground (Déjean 1990a).

Fossil records indicate that the genus *Oecophylla* has been around for 30 million years (Hölldobler and Wilson 1995). This genus includes two closely related species, *O. smaragdina* (found in Asia and Australia) and *O. longinoda* (found in Africa) both of which defend three-dimensional territories (Hölldobler 1979, 1983). While the nest trees form the central territory of an *Oecophylla* colony, the worker ants descend via tree trunks to the ground to patrol and forage on the ground area or the secondary territory. The captured prey is taken back to the leaf nests singly or in groups (Hölldobler 1983). Most of the research on the two *Oecophylla* species has been laboratory based (Hölldobler and Wilson 1977; Hölldobler and Wilson 1978; Beugnon and Déjean 1992; Déjean and Beugnon 1996) and only short-term field studies have been carried out (Hölldobler 1979, 1983; Déjean 1990a, b). There has been no report, so far, on the behavioural adaptations of the returning foragers of an arboreal ant species during heavy rains, the subject of the present study.

MATERIAL AND METHODS

The study was carried out as part of a long-term project on the behavioural ecology of *O. smaragdina* in the Banaras Hindu University campus, where five colonies were identified in an area of 3000 sq. m in July 1997. *Oecophylla smaragdina* was found to use up to 14 species of trees and shrubs for nesting, predominantly *Mangifera indica* (Anacardiaceae), *Psidium jambolana* and *P. guajava* (Myrtaceae). The southwest monsoon in Varanasi occurs from July-September and decreases rapidly during October (Srivastava 2001). Observations were recorded on 11 rainy days from July to October, 1998-2001. The orientation, posture, number and size of ant clusters were observed up to a height of 1.5 m on the nest-tree trunks. The behaviour of the returning ants was also recorded on sunny days during March, 2003. The number of returning ants crossing an arbitrary mark on the tree trunk, located between 0.5 m and 1.5 m high per minute was noted. (The mark was selected below the bifurcation on the tree trunk, to facilitate counting of all the returning ants before they diverged to different branches bearing the leaf nests).

The number of ants returning without prey, the number of solitary ants returning with prey and the number of ants returning collectively (in groups of 2 or more) with prey per minute were recorded by taking five observations on five different nest tree trunks between 0900 and 1300 hrs on three different days. Behavioural features such as orientation of the returning foragers on the tree trunk, interactions with other ants and clustering behaviour was noted. Number of ants and number of clusters is given as mean ±SD.

RESULTS

On sunny days, solitary returning foragers without prey (14.72 ± 13.14) and solitary ants with prey (2.76 ± 4.12) were observed to move straight upwards with head directed upward. An extremely brief encounter with a maximum duration of 1 second was noted in 90.66% of the returning ants and outgoing foragers. Returning foragers bringing a prey (0.2 ± 0.692) collectively (in groups of 2-3) were seen moving upwards while constantly changing their orientation as they held the prey from two or three sides and carried it up the tree trunk. Not a single solitary returning ant was seen with its head pointing downwards and no clumping was ever observed (n=75) (Fig. 1).

After the first few raindrops, the returning workers were seen moving slowly and hesitantly. The initial light drizzle slowed their upward movement on the tree trunk, but their heads remained directed upwards. Within 5 minutes of a heavy shower, a large number of the returning foragers (66.43 ±12.32% ants) adopted a head downwards position with their legs spread wide on the vertical surface of the tree trunk. The returning ants started aggregating into small clusters of 2-10 (6.66 ± 2.83 clusters). The cluster size increased with increase in the intensity of the rain, more ants joining each cluster, so that after 10-15 minutes moderate sized clusters each of 11-20 ants (2.4 ± 0.72 clusters) and of 21-50 ants (1.6 ±0.69 clusters) were also found (Fig. 2). Formation of large clusters of more than 50 ants (1.18 ±0.8 clusters) was recorded only 15-20 minutes after the rainfall began intensifying, as ants from smaller clusters as well as late returning foragers came close together (Fig. 2). The time period of adoption of head downwards orientation and increase in cluster size with intensification of rain is shown in Figs 3 and 4. Ants with head downwards were found to a greater extent in the upper parts of large clusters (Fig. 2).

Ants gripping prey in their mandibles were more often found to have their heads up and surrounded by other ants from all sides. Chains of ants on all sides gripped large prey

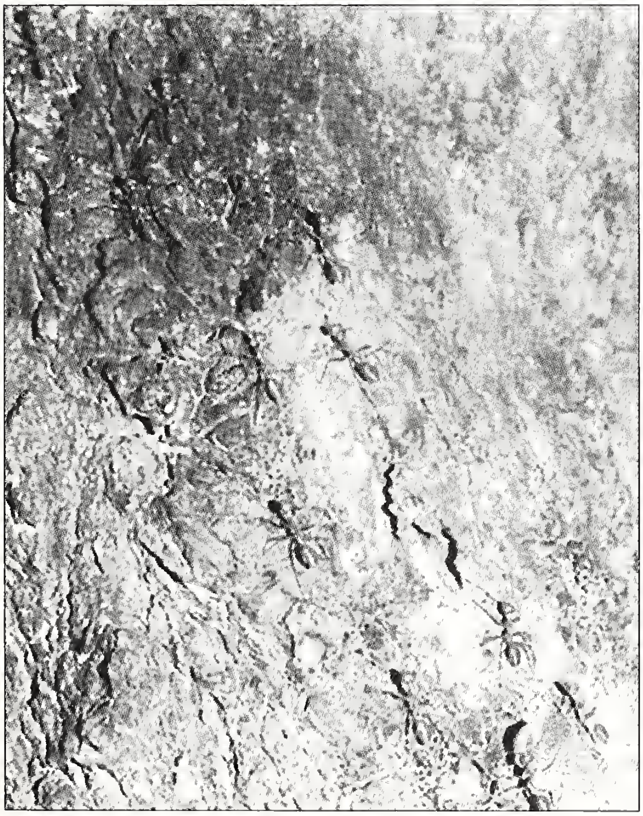

Fig. 1: Returning foragers moving up the tree trunk singly with head oriented in upward direction on a sunny day

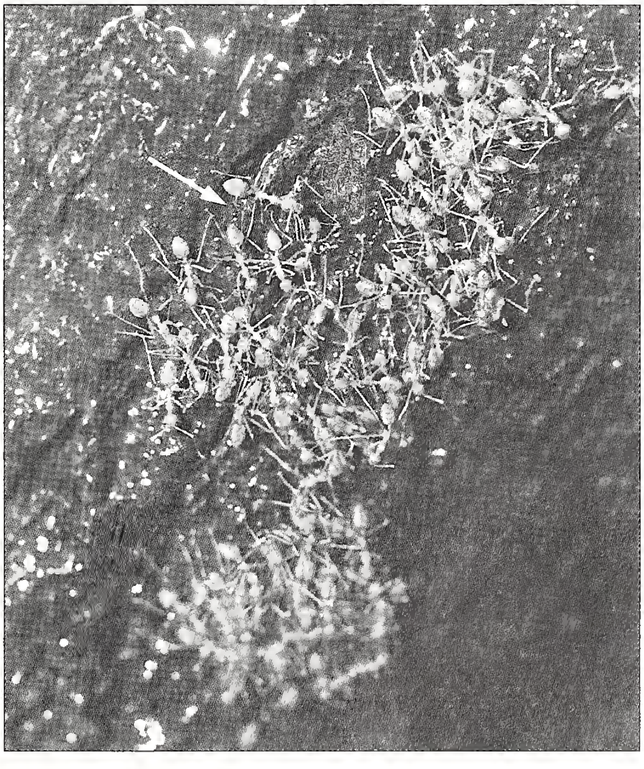

Fig. 2: Arrow shows that with increase in the intensity and duration of rainfall ants from moderate size clusters (11-20) move closer to form larger clusters (>50). White spots indicate the raindrops

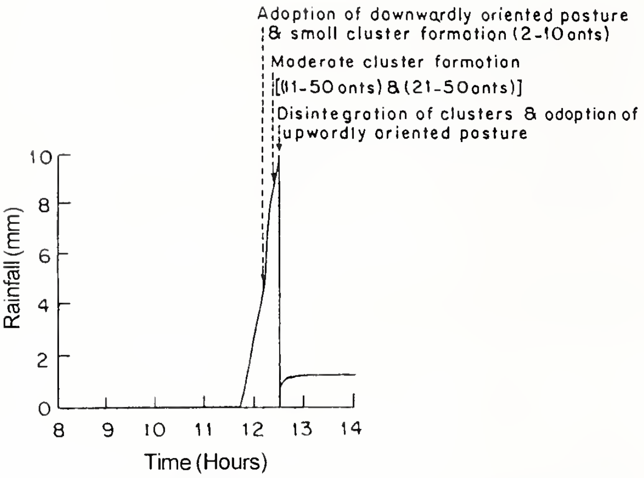

Fig. 3: Time sequence of adoption of head downwardly oriented postures and of progressive increases in cluster size with the intensification of rainfall on October 1, 1998. Total rainfall measured was 11.2 mm

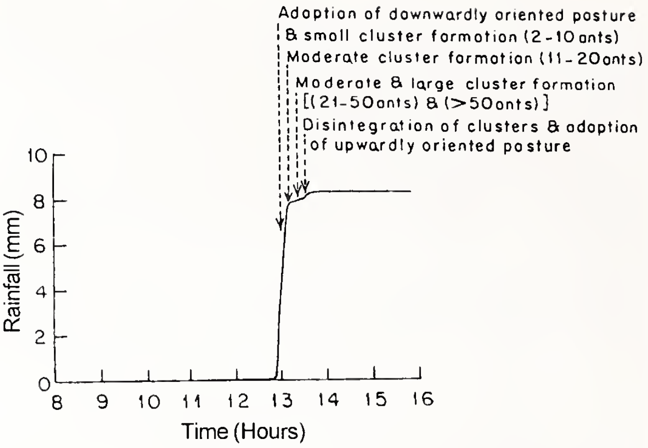

Fig. 4: Time sequence of adoption of head downwardly directed orientation and of progressive increases in cluster size with increase in duration and intensity of the rainfall on September 26, 2001. Total rainfall measured was 44.0 mm

such as grasshoppers and crickets.

The legs and body parts of the aggregated ants became meshed, as the clusters became tighter and more compact with intensifying rain. During heavy rain, the ants were found slowly but continuously changing their positions and coming closer to one another, so that when heavy rainfall lasted more than 30 minutes, extremely large clusters of more than 100 ants were found. The ants took shelter in the nooks between bifurcated parts of the tree trunk, under large, partially folded leaves of shrubs in contact with the trunk, or on the side of the tree trunk opposite to that facing the wind and rain. Within 10-30 seconds of the rainfall slackening, the clusters loosened rapidly, and the ants broke away from the aggregates, and in 2-3 minutes, they disintegrated completely as the ants moved to the leaf nests in their usual posture.

DISCUSSION

The arboreal ant *Oecophylla smaragdina* which nests in the leaves of trees and shrubs obtains honeydew from homopterans (Way 1954; Way 1963). However, the workers forage mainly on the ground, so they have to carry the food up the tree trunk to the leaf nests. Consequently, during heavy rain they are especially vulnerable, since they have to move up a slippery tree trunk, besides facing the falling rain drops. The present study shows that the ants have evolved a three-pronged behavioural strategy to avoid getting washed away during heavy rain. While the outspread legs provide stability on slippery, vertical tree trunks, the downwardly directed head posture probably helps in avoiding the direct onslaught of the raindrops on the head, as the ants slowly move about to form clusters in sheltered places in the tree trunk. Further stability as well as tighter grip on the slippery surface of the substratum is provided by cluster formation and the intertwining of legs and other body parts. The returning workers do not form clusters or show downward orientation on dry days (Fig. 1).

Wojtusiak and Déjean (1995) have demonstrated the importance of the arolia on the feet of *O. longinoda* for the successful capture and transport of large prey. I suggest that the well developed adhesive pads on the feet of *O. smaragdina* workers also play a crucial role in enabling the ants to grip and climb the slippery surface of tree trunks on a rainy day. The resistance of the trail pheromones, reinforced by faecal markings, to rainwater has been demonstrated in the African weaver ant *O. longinoda* for as long as ten months (Beugnon and Déjean 1992). Thus, while the arboreal nesting habit and leaf nests provide shelter from the rain, the trails marked by faecal spots are resistant to rainfall. Furthermore, adoption of downward direction and cluster formation strategy during heavy rain enables the returning workers to successfully ascend the tree trunks, seek temporary shelter from the rain and finally reach the nest. All these adaptive features have undoubtedly contributed to the success of *Oecophylla* in its tropical, arboreal habitat.

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MORTALITY OF HERPETOFAUNA, BIRDS AND MAMMALS DUE TO VEHICULAR TRAFFIC IN ETAWAH DISTRICT, UTTAR PRADESH, INDIA[1]

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Roadkills of herpetofauna, birds and mammals were enumerated along a 20 km stretch of road in Etawah district, Uttar Pradesh, in an agriculture dominated area. A total of 133 kills of 33 species of animals were recorded over two years. Amphibians and birds were killed significantly, more during the monsoon, while reptiles and mammals were killed almost equally across seasons. The species killed the most were the Marbled Toad *Bufo stomaticus* (amphibia), Flapshell Turtle *Lissemys punctata* (reptile), House Crow *Corvus splendens* (bird) and domestic Dog *Canis familiaris* (mammal). When all species present along the road for the taxa were considered, bird species were least represented in roadkills (16%), and higher proportions of species were killed in the other taxa (25-30%). Amphibians and birds were killed significantly more in the monsoon, while season did not affect numbers of kills for herpetofauna or mammals. Medium sized birds and omnivore bird species were killed the most. Accounting for all bird species present, number of birds of different sizes killed was in proportion to that present along the road. When guilds were considered, omnivore species were killed in much higher proportion to their availability along the road. No taxa of conservation concern was killed by traffic during this study. No species or taxa was killed to an extent that would endanger the species, though specific studies on species most vulnerable to vehicular traffic will be useful to determine how to prevent such mortalities.

Key words: Frequency of roadkills, herpetofauna, birds, mammals, *Bufo stomaticus*, *Lissemys punctata*, *Corvus splendens*, *Canis familiaris*

INTRODUCTION

Roads have been known to cause ecological effects like fragmentation, habitat loss due to deforestation, affect animal movement, cause changes in animal behaviour, and cause mortality due to accidents with vehicular traffic (van der Zande *et al.* 1980; Fahrig *et al.* 1995; Goosem 1997; Forman and Alexander 1998; Trombulak and Frisswell 2000; Develey and Stouffer 2001; Serrano *et al.* 2002). Vehicles on roads are thought to have overtaken hunting as the leading direct human cause of vertebrate mortality (Forman and Alexander 1998), often endangering local populations of common and threatened species (Clarke *et al.* 1998; Hódar *et al.* 2000; Huijser and Bergers 2000). In 1994, India had 3 million km of road, of which 50% were surfaced (Rajvanshi *et al.* 2001). In Uttar Pradesh alone, a total length of 1,21,761 km had been added in 1998-99 (Anon 2001). The direct or indirect impact of these roads on wild fauna has received very little attention in the country.

There is general awareness of the prevalence of mortality due to vehicular traffic of free-ranging vertebrates in India, and reports of such mortality are increasing (Dhindsa *et al.* 1988, Sharma 1988, Gokula 1997, Kumara *et al.* 2000, Rajvanshi *et al.* 2001, Vijayakumar *et al.* 2001). These studies have either listed kills (Sharma 1988, Gokula 1997, Rajvanshi *et al.* 2001), or addressed concerns to fauna in protected areas with special reference to effect of habitat on patterns of roadkill (Vijayakumar *et al.* 2001), and season on select fauna (Kumara *et al.* 2000). Few studies have explored community structure of vulnerable taxa along roads in an agricultural landscape in an effort to understand the potential species that may be affected by vehicular traffic (Dhindsa *et al.* 1988). Most of these studies have concentrated on mammals and herpetofauna, and reports on bird mortality due to vehicular traffic are few (Dhindsa *et al.* 1988, Sharma 1988). None of these studies have information on the proportion of species in an area affected by vehicular traffic. I studied some aspects of faunal mortalities due to vehicular traffic in Etawah district, Uttar Pradesh, in north central India. The study investigated the following questions.

1. What species of herpetofauna, birds and mammals are most affected by vehicular traffic and what proportion of species present are represented in roadkills?
2. Is faunal mortality due to vehicular traffic similar across seasons?
3. Are all avian groups present along the road (species, families, sizes, guilds) affected equally by vehicular traffic?

STUDY AREA

The study was carried out along the main road starting at Etawah town (26° 48' 51" N, 78° 59' 32" E) and ending at

Saiphai town (26° 57' 51" N, 78° 57' 52" E), on a stretch of road measuring 20 km. The road was metalled, a two-way traffic route with equal width throughout, and was busy since it was the only connecting road between Etawah and Mainpuri towns. Most of the heavy traffic was at night when buses plying northwards and trucks carrying cargo used the route. Daytime traffic comprised principally of tractors, smaller four-wheelers (cars, jeeps), and two-wheelers (scooters, motorbikes, mopeds). Speeds of the vehicles were as high as 110 kmph for four-wheelers, while two-wheelers reached speeds of 70 kmph. Three counts of vehicles, one each in summer, monsoon and winter, between 0730-0845 hrs in 2000 showed that an average of 56 vehicles ply every hour on the road with no significant difference in number of vehicles across seasons (χ^2_2=1.52, p>0.09).

Both sides of the road were bordered almost continuously with dry scrub and trees, behind which were crop fields, groves with fruit trees or habitation. Major trees along the road were *Dalbergia sissoo*, *Ficus benghalensis*, *Syzygium cumini*, *Mangifera indica*, and *Psidium gujava*, and the predominant shrubs were *Prosopis juliflora* and *Ipomoea aquata* with *Saccharum* sp. grass growing in few places. In addition, six village ponds of varying sizes, eight small (<10 ha) grassy marshlands, one alkaline wasteland, nine small towns (<ten houses each) and nine large towns (>ten houses each) bordered this stretch, and one small river and two canals intersected it. Only three village ponds were perennial due to disposal of sewage into them, while the rest were full only during and immediately after the monsoon, drying up in January/February. The region was thus suitable for a variety of fauna.

Three principal seasons could be differentiated based on rainfall and temperature regimes namely, winter (November-February), summer/ pre-monsoon (March-June) and monsoon (July-October). The main crops beside the stretch of road were barley, fruits, and paddy during May-November, and wheat and vegetables during November-April. In late June and early July, most fields were fallow until the rains. The main source of precipitation was the southwest monsoon with an annual average of 851 mm (1990-2002, District Collector's Office, personal communication), and fog/ dew in winter. Temperatures varied between 1 °C in winter to >45 °C in summer.

METHODS

Road kills were recorded for two years during January 2000 - December 2001. The road was patrolled one to six times a week between 0600-1000 hrs each sampling day driving at 20-35 kmph. Presence of highwaymen prevented evening and nighttime sampling. Effort was more or less constant over months and years. Every animal found killed due to vehicles was identified to the level possible and removed to avoid repetition. Most kills recorded were fresh with the complete animal available for identification. Only twice, kills of birds were ascertained from feathers left over by scavengers. To determine the number of species present along the road, opportunistic observations were maintained and all animals were identified to the species level. For mammals, bats were not considered. This enumeration is likely to be a minimum since many nocturnal species could have been missed. For birds, all species were classified into five size classes (very small, small, medium, large, very large), and grouped into eight feeding guilds (aquatic, carnivore, frugivore, granivore, insectivore, nectarivore, omnivore, and scavenger, as per Ali and Ripley 1989), and noted if they crossed the road. Statistical analyses were restricted to ascertaining if frequency of kills of individual taxa were different across seasons using χ^2 tests. Comparisons across taxa were not carried out since differences in removal rates of different sized animals, differential mortalities during day and night, and seasonal and species differences in densities of the various taxa were unknown and not controlled for. Bias due to the unaccounted animals which may have been struck by vehicles, but crawled away has not been corrected. It is known that speeds of vehicles, intensity of traffic, the kind of vehicles, width of the road, habitat conditions etc. also affect mortality (Dhindsa *et al.* 1988, Goosem 1997, Finder *et al.* 1999, Clevenger *et al.* 2003); these biases have also not been investigated or controlled for during this study.

RESULTS

Frequency of roadkills

The road was monitored for 226 and 230 days in 2000 and 2001 respectively, covering a total of 9,120 km. A total of 21 amphibians (three species, two families, rate of kill: 0.0023/km), 34 reptiles (six species, four families, rate of kill: 0.0037/km), 46 birds (17 species, 12 families, rate of kill: 0.005/km), and 32 mammals (seven species, four families, 0.0035/km) were recorded as roadkills (Table 1). Family Bufonidae was represented the most in amphibian kills (13/21), with the Marbled Toad *Bufo stomaticus* being killed most frequently (9/21). Among reptiles, the Flapshell Turtle *Lissemys punctata* was killed the most (10/34) and equal numbers of the families Boidae and Colubridae were killed (9/34 each). Among birds, species from four families, Corvidae, Sturnidae, Ardeidae and Rallidae, were killed the most (69% of 46 kills, Table 1). The House Crow *Corvus splendens* (n=6) and cattle egret *Bubulcus ibis* (n=5) were killed most frequently. In the family Sturnidae,

Table 1: Frequencies of roadkills of herpetofauna, birds and mammals in Etawah, Uttar Pradesh, India (January 2000 to December 2001)

Sl. No.	Taxa	No. of individuals (% of total)
	AMPHIBIANS	
I.	**Family Bufonidae**	**13 (61.91)**
	1. *Bufo melanostictus*	4 (19.05)
	2. *B. stomaticus*	9 (42.86)
II.	**Family Ranidae**	**8 (28.57)**
	3. *Hoplobatrachus tigerinus*	3 (14.29)
	Unidentified ranids	3 (14.29)
III.	**Unidentified frogs**	**2 (09.52)**
	Total	**21**
	REPTILES	
I.	**Family Boidae**	**9 (26.47)**
	1. *Eryx johnii*	9 (26.47)
II.	**Family Colubridae**	**9 (26.47)**
	2. *Xenochrophis piscator*	3 (08.82)
	3. *Oligodon sp.*	1 (02.94)
	4. *Ptyas mucosa*	5 (14.71)
III.	**Family Agamidae**	**1 (02.94)**
	5. *Calotes versicolor*	1 (02.94)
IV.	**Family Testudidae**	**10 (29.41)**
	6. *Lissemys punctata*	10 (29.41)
V.	**Unidentified reptiles**	**5 (14.71)**
	Total	**34**
	MAMMALS	
I.	**Family Canidae**	**23 (71.88)**
	1. *Canis familiaris*	19 (59.38)
	2. *C. aureus*	3 (09.38)
	3. *Vulpes benghalensis*	1 (03.13)
II.	**Family Felidae**	**5 (15.63)**
	4. *Felis chaus*	1 (03.13)
	5. Domestic cat	4 (12.50)
III.	**Family Herpestidae**	**3 (09.38)**
	6. *Herpestes javanicus*	3 (09.38)
IV.	**Family Sciuridae**	**1 (03.13)**
	7. *Funambulus palmarum*	1 (03.13)
	Total	**32**

Sl. No.	Taxa	No. of individuals (% of total)
	BIRDS	
I.	**Family Picidae**	**1 (02.17)**
	1. *Dinopium benghalense*	1 (02.17)
II.	**Family Upupidae**	**1 (02.17)**
	2. *Upupa epops*	1 (02.17)
III.	**Family Coraciidae**	**3 (06.52)**
	3. *Coracais benghalensis*	3 (06.52)
IV.	**Family Centropodidae**	**3 (06.52)**
	4. *Centropus sinensis*	3 (06.52)
V.	**Family Psittacidae**	**2 (04.35)**
	5. *Psittacula krameri*	2 (04.35)
VI.	**Family Rallidae**	**5 (10.90)**
	6. *Amaurornis phoenicurus*	5 (10.90)
VII.	**Family Ardeidae**	**7 (15.20)**
	7. *Bubulcus ibis*	5 (10.90)
	8. *Ardeola grayii*	2 (04.35)
VIII.	**Family Corvidae**	**10 (21.80)**
	9. *Corvus splendens*	6 (13.04)
	10. *C. macrorhynchos*	4 (08.70)
IX.	**Family Sturnidae**	**9 (19.60)**
	11. *Sturnus pagadorum*	1 (02.17)
	12. *S. contra*	3 (06.52)
	13. *Acridotheres tristis*	4 (09.70)
	14. *A. gingianus*	1 (02.20)
X.	**Family Cisticoliidae**	**2 (04.35)**
	15. *Prinia inornata*	2 (04.35)
XI.	**Family Sylvidae**	**1 (02.17)**
	16. *Turdoides malcolmi*	1 (02.17)
XII.	**Family Passeridae**	**2 (04.35)**
	17. *Passer domesticus*	2 (04.35)
	Total	**26**
	Total kills	**133**

all four species present in the area were represented in kills. Among mammals, the Family Canidae was represented most in roadkills (23/32), with Dogs *Canis familiaris* being killed the most (19/32). Among wild species, Jackals *C. aureus* and small Indian Mongoose *Herpestes javanicus* were killed the most (3/32 each), and one kill each was recorded of the Fox *Vulpes benghalensis*, Jungle Cat *Felis chaus* and Palm Squirrel *Funambulus palmarum* (Table 1).

Species richness along the road was the lowest for herpetofauna and the highest for birds (Table 2). At the family level, the representation in roadkills varied widely across taxa with most of the amphibian families present being killed and very few of the mammal families present being represented in roadkills (Table 2). At the species level, except for birds that had a very small proportion of species present along the road being killed (16%), the other taxa were very similar in terms of proportion of species represented in roadkills (25-30%, Table 2). Of the species present along the road, all species of

Table 2: Species richness of herpetofauna, birds and mammals found along the road and as roadkills in Etawah, Uttar Pradesh, India (January 2000-December 2001)

Taxa	Number present		Number seen in roadkills (proportion of total)	
	Families	Species	Families	Species
Amphibians	3	10	2 (67)	3 (30)
Reptiles	10	24	4 (40)	6 (25)
Birds	40	104	12 (30)	17 (16.4)
Mammals	15	24	4 (29)	7 (27)

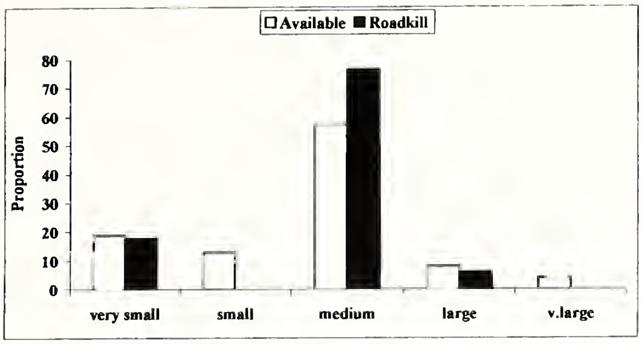

Fig. 1: Effect of body size on vulnerability of birds to traffic in Etawah, Uttar Pradesh, India

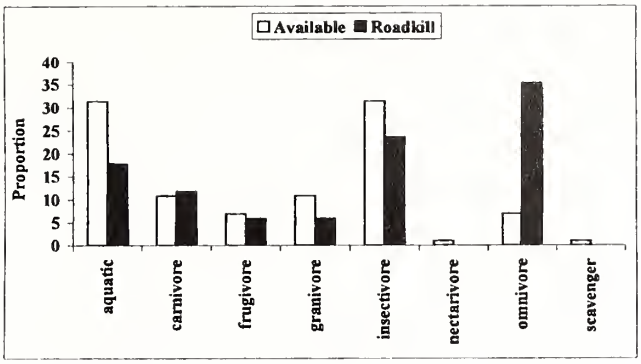

Fig. 2: Representation of guilds of birds along the road and in roadkills in Etawah, Uttar Pradesh, India

amphibians and mammals were seen to cross the road at least once. Among the reptiles, 16 of the 27 species seen along the road (66.6%) were seen to cross the road at least once and for birds, 89 of the 104 species listed along the road (85.6%) were seen to cross the road at least once at a height that would render them vulnerable to be killed by vehicles. All species represented in roadkills were from this list.

Effect of season of frequency of roadkill

There was no significant inter-annual difference in the rate of kills, or number of species killed for any taxa (χ^2_1 test, $p>0.1$ in all cases) and kills were pooled seasonally. Sufficient data for seasonal analyses each year was available only for birds. Amphibians were killed disproportionately more in the monsoon ($\chi^2_2=14$, $p<0.001$, Table 3) while reptiles and mammals were killed in nearly equal numbers in all seasons (χ^2 tests, $p>0.1$). While birds were killed in nearly equal proportions across seasons in 2000 ($\chi^2_2=5.33$, $p>0.05$), a significantly high number were killed during the monsoon in 2001 ($\chi^2_2=16.7$, $p<0.001$). For the pooled information, significantly more birds were killed during the monsoon ($\chi^2_2=18.57$, $p<0.005$). The least kills for amphibians, reptiles and mammals were in summer, while birds were killed the least during winter (Table 3).

Effect of size and guild on frequency of roadkills of birds

All the bird species represented in road-kills were resident and diurnal. Most birds killed were of medium size (76.5%, Fig. 1). Very small and medium sized birds were represented in roadkills in nearly the same proportions as those present along the road, while small and very large birds were not killed (Fig. 1). Most kills were of omnivore (35.3%), insectivore (23.5%), and aquatic species (17.7%, Fig. 2). Omnivore species were killed in far higher proportion than present along the road, while insectivore and aquatic species were killed in lesser proportions (Fig. 2). To examine effect of size and guild on vulnerability of birds to vehicular traffic, sample sizes obtained were too small to carry out statistical analyses.

Table 3: Seasonal effect on frequency of roadkills of herpetofauna, birds and mammals in Etawah, Uttar Pradesh (January 2000-December 2001)

	Number killed		
Taxa	Summer	Monsoon	Winter
Amphibians	2	15	4
Reptiles	11	7	16
Birds	10	29	7
Mammals	8	12	12

DISCUSSION

Herpetofauna

Very few kills of amphibians were obtained and most of them were during the monsoon. However, these animals are small and carcasses on roads do not probably last very long on the road, and the estimates obtained during this study must be taken to be a minimum. An increase in mobility and activity of amphibians due to rains leads to their increased mortality due to vehicular traffic (Vijayakumar *et al.* 2001). Vijayakumar *et al.* (2001) recorded much higher rates of roadkills for both amphibians (2/km) and reptiles (0.4/km) than this study, but these were obtained from a forested area. There are no studies on roadkills of herpetofauna in the country from non-forested on non-protected areas to compare the results of the present study. Traffic does not seem to be a major concern for amphibians in Etawah. In Mudumalai, Gokula (1997) found more kills of snakes during the daytime as compared to evenings and nights. Vijayakumar *et al.* (2001) found no influence of rain on mortality rates of reptiles, as was recorded by this study. Kumara *et al.* (2000), however, found a significant positive relationship between the rainy season and number of reptiles killed, particularly uropeltid snakes. When uropeltids were considered separately, other snakes showed no relationship between mortality rates and rainfall, similar to that found in Etawah. Many species of reptiles that are strictly arboreal such as the geckos and those restricted entirely to canals and rivers such as the hard-shelled turtles were found along the road but were not represented in roadkills. Monitor lizards *Varanus benghalensis* and *V. flavescens* were seen killed in other roads in the area, but not represented on the study road.

Amphibians are clearly more susceptible to mortality by vehicular traffic during the rains due to increased activity, most likely related to breeding. However, most reptiles killed in Etawah were in the winter. The dark surfaces of the roads usually retained heat much later than the soil possibly attracting reptiles. Kills of *B. stomaticus*, *E. johnii* and *L. punctata* were very high and specific studies on these species may be worthwhile to ascertain exact causes and reduce or even prevent such high mortalities.

Birds

This study suggests that mortality due to vehicular traffic affects only a small proportion of species in an area, medium-sized birds are affected the most, omnivore and insectivore species are more vulnerable than species belonging to other guilds, and most kills occur during the monsoon. It appears that vehicular traffic causes minimal mortalities of birds, and is unlikely to be a matter for concern. Numbers of birds of each species were much lower in roadkills compared to actual numbers along the road. Majority of the species present crossed the road implying that the road is not perceived as a barrier by most bird species and that almost all the birds are vulnerable to vehicular traffic. The rate of roadkills of birds recorded in this study, however, was far lesser than that recorded for a similar habitat type in Rajasthan, about 200 km west of the study site. Sharma (1988) recorded a total of 219 kills of 26 species of 19 families in one year in a stretch of five km of road. He found that the Eurasian Collared Dove *Streptopelia decaocta* was killed the most in Rajasthan but was never represented in roadkills in Etawah. In Rajasthan, aquatic birds were killed the least, but the globally threatened sarus crane *Grus antigone* was represented in kills. The rate of roadkills was 0.12 kills/km (calculated from the study assuming that sampling was carried out for 365 days), 24 times higher than that recorded during this study. There was, however, no information on the species composition of the bird community along the road. The bird community structure is likely to be similar with Etawah, and it is interesting that different results were recorded. Vegetation structure, traffic intensity, and other factors such as fallen grain on the road etc. may have contributed to the differences in patterns of roadkills.

In Etawah, presence of few fruiting trees along the road caused large amounts of ripe fruits to be available on the road during the fruiting season and resulted in the deaths of mynas and crows foraging on fallen fruits. Crows were further killed when they were scavenging roadkills. The only rallid represented in kills, the White-breasted Waterhen *Amaurornis phoenicurus*, was found living in roadside ponds. Kills could have occurred either during foraging events or during territorial fights with conspecifics. The author nearly ran over one individual which was engrossed in an aggressive interaction with another bird in the middle of the road, and when the motorbike was near them, broke away quite unpredictably and ran towards the motorbike. Several passerines were also seen to engage in territorial disputes, an activity that would make them more vulnerable to approaching traffic. The Greater Coucal *Centropus sinensis* was seen to be a nest predator and often carried away eggs and nestlings from nests alongside the road. One kill each was recorded in May, September and November of this species. Many species of birds were seen nesting along the road during these months.

The Lesser Golden-backed Woodpecker *Dinopium benghalense* and Rose-ringed Parakeet *Psittacula krameri* usually foraged on tree trunks and in the canopy respectively and were correspondingly under represented in road kills. The sole *D. benghalense* killed during the study was found near the entrance of a termite colony from which alates were emerging. The bird had flown down to feed on the alates fleeing the colony, as was confirmed by its stomach contents. *P. krameri* deaths occurred when flocks were chased off from adjoining fields while they were depredating crops. The two parakeets found killed had large quantities of wheat in their stomachs. Occasionally, individuals were seen foraging on fallen fruit of *F. benghalensis* and *P. gujava* on the road and this may lead to deaths occasionally. Ardeids take a longer time to attain height when they take off as compared to other bird species. After taking off from marshlands and ponds adjoining the road, they tended to fly low over the road making them susceptible to speeding traffic. Though White-necked Storks *Ciconia episcopus* and Sarus Crane *Grus antigone* nested along the road on trees and wetlands respectively, these large waterbirds were not killed by traffic during the study period. Food on roads and specific behaviour (e.g. territoriality) at certain times seem to be responsible for kills of birds on roads. Additional species that were found killed due to traffic on other roads near the study road but not represented in this study were the White-throated Kingfisher *Halcyon smyrnensis*, *Streptopelia decaocto*, *Grus antigone*, and Red-vented Bulbul *Pycnonotus cafer*.

Mammals

Of the seven species of mammals found killed in the study, none were of conservation concern. One species, *F. palmarum*, was arboreal and the rest were ground dwelling. Both the Fox and the Jungle Cat were killed during the night. The other nocturnal animals that were seen along the road were the Striped Hyaena *Hyaena hyaena*, Common Palm Civet *Paradoxus hermophroditus*, and Indian Pangolin *Manis crassicaudata* but were not killed by traffic during the study. These animals were sighted in the early morning. One Pale Hedgehog *Paraechinus micropus* was found killed by traffic after the completion of the study. Previous accounts of roadkills on mammals in India have been restricted to protected and forested areas and have documented deaths of many species of conservation concern (Kumara *et al.* 2000, Rajvanshi *et al.* 2001). Kumara *et al.* (2000) found no influence of either habitat type or season on rates of mortality of mammals in a protected area, quite similar to the patterns observed in Etawah. Mammals had relatively low mortality rates in summer. The region along the road was particularly dry in summer months and mammals may have moved away at this time. Most of the deaths (6/8) observed in this season were of domestic animals (dogs, n=4, cats, n=2) lending some credence to this surmise.

Implications of the study

This study suggests that mortality rates due to vehicular traffic is quite low for all the taxa studied, and that populations of most species may not be significantly affected by roadkills due to traffic. No species of conservation concern was killed by traffic during this study. The results of this study are in contrast with those obtained from other regions in the country. Roads in agricultural areas do not seem to be causing large-scale mortalities of vertebrate fauna. However, many more studies away from protected and forested areas are required to ascertain the actual magnitude of roadkills in relation to populations of particular species. Studies elsewhere have documented that roads perform as physical barriers to movements of animals often changing their behaviour (Daveley and Stouffer 2001), and that animal densities are affected by the presence of roads (Fahrig *et al.* 1995, van der Zande *et al.* 1980). The overall disturbance effect of roads on wildlife would therefore be underrepresented by roadkills and animals are possibly affected much more by other effects of roads such as habitat fragmentation, stress due to noise of traffic etc. (van der Zande *et al.* 1980, Goosem 1997, Forman and Alexander 1998). Considering that the Government of India is undertaking several large-scale expansions of the road network in Uttar Pradesh and in the rest of the country, many more studies are required before we can hope to better understand the impact of roads on wildlife in the Indian countryside.

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ARE WORMS AFFECTED BY HOST ECOLOGY? A PERSPECTIVE FROM MUDUMALAI WILDLIFE SANCTUARY, SOUTHERN INDIA[1]

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Interspecific comparisons of helminth loads, using helminth eggs per gram of faeces as an index, were done in the Mudumalai Wildlife Sanctuary between May and August, 1999. The host species sampled were chital (*Axis axis*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), elephant (*Elephas maximus*) and domestic cattle. Helminth distributions in all the species were highly over dispersed and except in the case of gaur the negative binomial distribution gave good fits to the observed data. In general, it was found that the elephant and gaur had higher loads than the cervids, probably due to their larger body size. Among the cervids, sambar had lower loads than chital probably because they are mixed feeders as opposed to chital, which are mainly grazers. Cattle had the highest loads and prevalence of parasites among all the species studied, probably due to the effects of domestication and poor hygiene. Helminth community structure and species diversity was related to the taxonomic distinctiveness of the host. It is thus likely that many interspecific differences in helminth loads can be explained by the existing hypotheses related to host ecology.

Key words: Helminths, *Axis axis*, *Cervus unicolor*, *Bos gaurus*, *Elephas maximus*, cattle

INTRODUCTION

Wildlife conservation, with population health as an important component, has emerged as one of the greatest challenges of our time. However, the existing knowledge on wildlife disease is of little help when dealing with population health, as most of this information has accumulated through "investigation of individual animals rather than populations" (Spalding and Forrester 1993). In spite of this, there have been only a few studies (Arora *et al.* 1985, Watve 1992, Bhatt 1994), in India, on helminths in free-ranging wildlife populations. This according to Davis and Anderson (1971) could be because "it was a common theme that the parasites of wild animals were so perfectly adapted to their host that under natural conditions they would not cause disease." However, research has shown that this premise is not true with parasite affecting the survival of their host directly (Choudhary *et al.* 1987, Nudds 1990) or indirectly (Freeland 1981, Schall 1983, Rau 1984, Saumier *et al.* 1986). For a clearer picture of helminth epidemiology in wild herbivores, it is essential to understand the ecological factors that affect the magnitude of infection in the host species.

STUDY AREA

The study area comprises the Mudumalai Wildlife Sanctuary and National Park, and the Sigur Reserve Forest, situated between 11° 32'-11° 93' N and 76° 22'-76° 43' E. Elevations vary between 900-1,000 m above msl. There is a decrease in rainfall from the western side (1,800 mm/year) to the eastern side (600 mm/year). A high diversity of vegetation types has been observed (Sukumar *et al.* 1992).

MATERIAL AND METHODS

Hosts sampled: Species of host included were chital (*Axis axis*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), elephant (*Elephas maximus*) and forest grazing domestic cattle.

Coprological study: Helminth eggs per gram of faeces (epg) have been used as an index of helminth load. A representative sample of approximately 2 gm was collected from clearly demarcated, fresh dung piles voided by the target species. Samples were collected in labelled, pre-weighed containers with 10 ml of 10% formalin between 0700 and 0900 hrs daily. The exact weight of faeces collected was calculated by subtracting the weight of the container with formalin from the weight of the container containing the dung sample in formalin. The intensity of helminth infection was determined by the quantitative Sedimentation-floatation Technique developed and standardized by Watve (1992). Prevalence of strongyle genera were calculated using data obtained from larval cultures. Samples for larval cultures were collected separately in cloth bags, kept moist, and cultured in the laboratory within 12-15 hours after collection. Larval cultures for third stage (infective) strongyle larvae were done as per Roberts and O'Sullivan (1949). Larvae were identified with the help of keys provided by Davies (1984). Larvae

Table 1: Distribution of helminth eggs in selected species of wild herbivores and domestic cattle at the Mudumalai Wildlife Sanctuary, Tamil Nadu

Host Species	Sample size	% Infected	Median Load (epg)	Mean Load (epg)	Variance	Index of Dispersion	d-statistic	Negative Binomial Parameters	
								k	χ^2
Chital	214	74.77	2	3.88	191.53	49.32	124.34*	0.76	19.81^{ns}
Gaur	54	85.19	3	11.93	684.82	57.42	67.77*	0.64	40.47*
Elephant	34	85.29	3.5	4.15	45.04	10.86	18.71*	1.38	7.24^{ns}
Sambar	36	58.34	1	1.22	11.49	9.40	17.35*	1.38	3.51^{ns}
Cattle	56	91.07	5.5	7.84	156.35	19.95	36.4*	1.19	12.52^{ns}

epg-eggs per gram of faeces; *- Statistically significant, ns- not significant (see text for details)

cultured from elephant dung were identified by measurements given by Raman (Unpubl. Data).

Terminology: Helminth loads have been expressed in terms of eggs per gram of faeces (epg). In this study, the term has been broadened to include larvae of lungworms also. The term "species" has been used loosely to describe distinct groups of parasites. Thus, for example all fluke eggs are classified as a single 'species'. Though the term 'Operational Taxonomic Unit' as used by Watve (1992) is more accurate, the term species is retained because of familiarity in usage. The total number of such "species" has been used as an index of "Parasite diversity" in the host community. Because of the methodology used, definitions of some terms used here are different from Margolis *et al.* (1982). The term 'prevalence' indicates percentage of samples found to be positive for helminth eggs and/or larvae. The term sympatric is defined as (of biological speciation or species) taking place or existing in the same or overlapping geographic areas (Hanks 1979). This term has been used synonymously with co-grazing.

Statistical Analyses: Calculation of index of dispersion, d-statistic and fitting of the negative binomial distribution has been done as per Ludwig and Reynolds (1988). The d-statistic was termed significant if >1.96. All other statistics were tested at a probability level of 5%.

RESULTS

The distribution of helminths in all host species sampled was highly non-random or over-dispersed as the d-statistic was >1.96 (Table 1). The negative binomial distribution in general gave good fits to the observed data in the case of all the species studied, with the exception of gaur (Table 1). Interspecific comparisons of helminth loads were carried out using three main parameters. These parameters were the prevalence of infection (Percentage of animals infected), median egg load (in epg) and total number of parasite species (parasite species richness) in the study animals. The median egg load was chosen in preference to the mean because in over-dispersed populations a few outlying individuals can drastically affect the latter. The parasites identified in the hosts showed that most host species, with the exception of elephants, had similar parasitic genera (Table 2).

Table 2: Helminth species identified in the hosts sampled

Host	Parasite species identified	Parasitic diversity
Chital	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., *Cooperia* sp., hookworm, *Muellerius* sp., *Dicrocoelium* sp., *Cotylophoron* sp., *Nematodirus* sp., trichurid, fluke, ascarid, strongyloid, anoplocephalid and spirurid	16 species
Sambar*	strongyle, fluke, *Muellerius* sp. and strongyloid	4 species
Gaur	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., hookworm, *Muellerius* sp., fluke, protostrongylus, strongyloid, anoplocephalid, trichurid and spirurid	12 species
Elephant	*Murshidia* sp., *Quilonia* sp., *Decrusia* sp., *Bathmostomum* sp., fluke, spirurid and anoplocephalid	7 species
Cattle	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., *Cooperia* sp., hookworm, fluke, ascarid, strongyloid, *Moniezia* sp., trichurid, *Dicrocoelium* sp. and *Nematodirus* sp.	13 species

* Larval culture data not obtained for host species.

DISCUSSION

In this study, egg per gram of faeces (epg) was used as an index of helminth load in the host. Though this method has limitations as pointed out by Foreyt and Trainer (1980), faecal examination is non-invasive and thus has great appeal especially in wild animals. Because of positive correlation between worm size and egg output (Skorping *et al.* 1991), egg outputs can be considered to be an accurate indicator of parasite biomass, if not numbers. Faecal egg counts can thus give very valuable assistance in studies concerning helminth populations (Roberts *et al.* 1951).

Prevalence of infection and median egg loads: It was found that the two larger herbivores sampled, namely elephants and gaur, had the highest prevalence of infection (85.29% and 85.19% respectively) and median loads (3.5 and 3 epg respectively), as compared to that of cervids — chital and sambar. This could be due to three major reasons. Firstly, larger animals tend to consume large quantities of food and water, and thus have greater chances of picking up infective parasitic stages (Kennedy *et al.* 1986). Secondly, as larger animals have larger gastrointestinal tracts, the "crowding effect" as described by Read (1951) is less likely to be of importance, thus allowing these animals to support larger numbers of parasites without reductions in parasite size and fecundity. Thirdly, as body size increases there is a decrease in predatory pressures. In Mudumalai, sambar and chital are preyed upon by leopards, tigers and wild dogs, while gaur is mostly preyed upon by tiger. Elephants do not form the usual prey base of any carnivore. Since parasites can decrease the ability of animals to escape predation either directly, by reducing running stamina (Schall *et al.* 1982) or indirectly, by causing debility (Soulsby 1982), animals like deer with high predatory pressures are likely to evolve higher resistance to infection by way of natural selection. Additionally, if carnivores select prey with poor body condition (Kruuk 1972) they may selectively remove animals with high parasite loads from the population, thus reducing a major source of infection to other animals.

Among the cervids studied, sambar had lower prevalence of infection and median egg loads (58.34% and 1 epg respectively) as compared to chital (74.77% and 2 epg). It has been observed that sambar is a mixed feeder, both grazing and browsing, as compared to chital which is predominantly a grazer (Schaller 1967). Since browsers tend to have lower loads of parasites (Horak 1984), mainly as a result of less contact with the infective stages of the helminths, which are found mainly in the soil or on grass, the higher helminth load in chital can be attributed to this reason.

Cattle were found to have the highest levels of parasite prevalence (91.07) as well as median egg loads (5.5 epg) and this could be due to two reasons. Firstly, it has been hypothesised that domestication tends to tilt the "natural balance" in favour of parasites (Gordon 1948). Secondly, the cattle grazing in Mudumalai are kept in pens during the night. The high levels of crowding in these pens will create an environment that is conducive for the increased transmission rates of parasites (Solomon 1965). Poor hygiene in the pens is likely to exacerbate these high transmission rates, and thus contribute both to the high parasite prevalence rates and helminth loads observed in cattle.

Parasite species richness: The richness of parasite fauna varied widely among different species of host. Taxonomically related host species tend to share parasite species (Cameron 1964, Segun 1971), which may be due to immunological reasons (Freeland 1983). Thus, host species with a large number of related species in the same area can be expected to have high parasite species richness. This was so in our findings, with chital having the greatest parasite diversity (16 parasite species) followed by gaur (12 species) and forest grazing cattle (13 species). Elephants with no close relatives had the lowest species diversity (7 species). Sambar was not considered for comparison, as larval culture data for this species could not be obtained. Using larval culture data, which allows identification of strongyles up to the generic level, it was found that the ruminants (chital, gaur, cattle) had very similar parasitic genera. This is well in agreement with Horak (1981). Elephants, which were phylogenetically distinct from other herbivores, were found to have a distinctive strongyle community structure composed of *Murshidia* sp., *Decrusia* sp., *Quilonia* sp. and *Bathmostomum* sp. Generic level identification of other parasites was only possible in a few cases wherein the egg morphology was very distinct (e.g. *Trichuris* sp.).

From the management point of view, the fact that the cattle entering the Sanctuary have the highest worm loads among the herbivores, and also have many parasitic genera in common with the wild herbivores, should be viewed with concern. Dharmarajan *et al.* (2003a, b) shows that such cattle may have adverse effects on chital populations.

In conclusion, it may be stated that differences in parasite loads and helminth community structure between different species of wildlife and forest grazing domestic cattle in Mudumalai can be explained by the existing ecological hypotheses. The major parameters are likely to be species of host, phylogenetic distinctiveness, feeding habits and domestication. More work is required to identify the relative importance of the various factors influencing the distribution of helminths within and between populations of host species studied in Mudumalai.

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CLADOCERA OF PERIYAR LAKE AND ADJACENT SITES, THEKKADY, KERALA[1]

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The cladoceran fauna of Periyar Lake and adjoining water bodies, situated in the Periyar Tiger Reserve, Kerala, was studied. The present paper deals with the systematic study of 23 species, based on random collections. Females of *Alona clathratula* Sars, *Camptocercus uncinatus* Smirnov, *Biapertura intermedia* Sars and males of *Diaphanosoma sarsi* Richard and *Ceriodaphnia cornuta* Sars were recorded for the first time from India.

Key words: Cladocera, Periyar Lake, systematic study, distribution, India

INTRODUCTION

A review of literature on the freshwater Cladocera of Kerala, India reveals that no attempt has been made to study this fauna. Michael and Hann (1979) reported two species from Thiruvananthapuram. In 1988, Michael and Sharma added eight species from Thiruvananthapuram and nine from Irinjalakuda to the cladoceran fauna of Kerala. Other studies are by Thresiamma *et al.* (1991) on population dynamics, and Subhash Babu and Nayar (1993, 1997) on biology. The present study is a preliminary survey of the microfauna of the aquatic habitats in and around Periyar Lake.

Periyar Lake was formed a century ago due to the construction of the Mullaperiyar dam across River Periyar in 1895. It is situated within the Periyar Tiger Reserve and has an area of 26 sq. km. Periyar Tiger Reserve lies between 9° 15' and 9° 40' N, and 76° 55' and 77° 25' E in the Western Ghats, in Idukki district, Kerala. The height of the Reserve varies from 900 to 2,019 m. The temperature is 15.5 °C during December-January and 31 °C during April-May. The average annual rainfall is 2,500 mm, including both southwest and northeast monsoon.

Although we have information on the terrestrial fauna of Periyar Tiger Reserve, our knowledge of the aquatic fauna is limited. Recently, Zacharias *et al.* (1996) reported the presence of 35 species of fishes in this area, based on collections from lakes and rivers. The crustacean group Cladocera is an important component of freshwater zooplankton.

MATERIAL AND METHODS

Samples from water bodies and canals adjacent to the Lake were collected with the help of a tow net made of bolting silk (70 µm). Specimens were also obtained by washing the weeds collected from the lake and other water bodies. The samples were immediately preserved in 5% formaline. Dissections were done wherever necessary, using tungsten micro-needle and drawings were made with the help of camera lucida. Measurements were made using calibrated micrometers.

SYSTEMATIC ACCOUNT

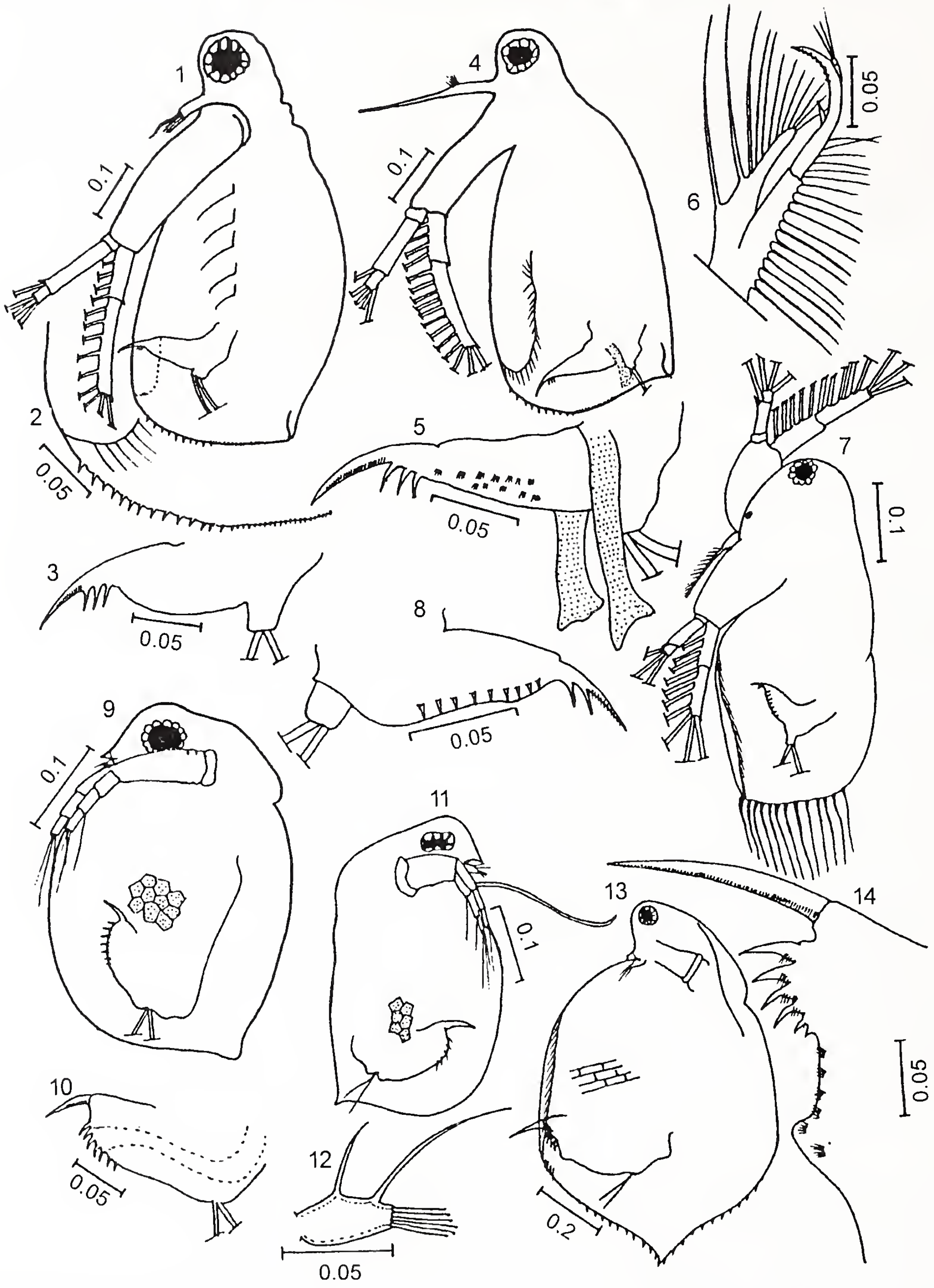
Cladocera are generally considered an artificial group comprising representatives of rather different phylogenetic origin. Fryer (1987) classified the "group" Cladocera into 4 Orders, Ctenopoda, Anomopoda, Onychopoda and Haplopoda.

Class: Crustacea
Subclass: Branchiopoda
Order: Ctenopoda
Family Sididae Baird, 1850
1. ***Diaphanosoma sarsi*** Richard, 1894 (Figs 1-6)

This typical planktonic species was represented by 13 specimens in the samples collected from the littoral regions of the lake. The specimens included 8 parthenogenetic females, 3 ephippial females and 2 males.

Parthenogenetic female: Body somewhat elongated and transparent (Fig. 1); head small with relatively large eyes; without rostrum; valves with varying number of denticles along the posterior ventral corner (Fig. 2); ventral margin inflexed to form a broad flap; antennules small, cigarette-shaped with terminal setae; antennae large but not reaching posterior margin of valves; dorsal ramus 2-segmented and ventral ramus 3-segmented; postabdomen without anal spines; claw with 3 long basal spines (Fig. 3); ephippial female carries 2 ephippia, one on each side.

Male: Smaller than female, characterised by the



Figs 1-6: *Diaphanosoma sarsi* Richard; 1. Female, 2. Shell duplicature, 3. Postabdomen of female, 4. Male, 5. Postabdomen of male, 6. Endopodite of first thoracic leg of male;
Figs 7-8: *Latonopsis australis* Sars; 7. Female, 8. Postabdomen of female;
Figs 9-12: *Ceriodaphnia cornuta* Sars; 9. Female, 10. Postabdomen of female, 11. Male, 12. Antennule of male;
Figs 13-14: *Simocephalus latirostris* Stingelin; 13. Female, 14. Postabdomen of female

presence of long whip-like antennule (Fig. 4), postabdomen with two long sperm ducts (Fig. 5); endopodite of first thoracic leg modified to form a sickle-shaped hook (Fig. 6).

Size: Female - 0.86 x 0.38 mm, Male - 0.67 x 0.32 mm.

Remarks: Females reported by Raghunathan (1989) from Wynaad, Kerala; males reported for the first time from India. Earlier reports of this species from India include those of Gurney (1907) from Bihar, Biswas (1971) from Rajasthan, Patil (1976) from Meghalaya, Sharma (1978), Venkataraman and Das (2001) from West Bengal, and Michael and Sharma (1988) from Tamil Nadu, West Bengal and New Delhi. *D. sarsi* is a widely distributed species known from Asia, Africa and Australia.

2. ***Latonopsis australis*** Sars, 1888 (Figs 7-8)

A few females of this species were present in the samples collected among the littoral weeds of the lake and a nearby ditch.

Female: Body elongated; head indistinctly separated from rest of body (Fig. 7); posterior margin of valves with long plumose setae decreasing in length dorsally; antennule segmented with a long flagellum beset with sensory setae; antenna prominent with 3-segmented dorsal ramus and 2-segmented ventral ramus; valve with characteristic shell gland; postabdomen small, with 8-9 marginal spines and claw with 2 long basal spines (Fig. 8).

Size: 1.06 x 0.61 mm.

Remarks: First report from Kerala State. Michael and Sharma (1988) reported the occurrence of this species in Madurai (Tamil Nadu) and Rajasthan. Their specimens differ from the present specimens in having 3 long setae at the posteroventral corner of the valves, and a short postabdomen with only 7 lateral denticles. The specimens from Thekkady, however, show remarkable similarity with *L. australis* described by Korovichinsky (1992) from Queensland, Australia. *Latonopsis occidentalis* Birge, reported by Biswas (1971) from Rajasthan is considered a synonym of *L. australis* by Harding and Petkovski (1963). Venkataraman (1992, 1993, 1995) reported this species from Keoladeo National Park, Rajasthan, and Tamil Nadu. Venkataraman and Das (2001) also reported *L. australis* from West Bengal.

Order: Anomopoda

Family Daphniidae Straus, 1820

3. ***Ceriodaphnia cornuta*** Sars, 1885 (Figs 9-12)

This species was abundant in the samples collected from the lake and nearby habitats. The population comprised parthenogenetic females, ephippial females and a few males.

Female: Body of parthenogenetic female somewhat rounded in outline (Fig. 9); head small, distinctly separated from rest of body by a conspicuous cervical sinus; ventral margin of head produced into a short rostrum in front of antennules; valves with distinct polygonal markings; margins smooth; posterodorsal corner produced into a blunt process; antennule short, not extending beyond tip of rostrum; horn-like process may or may not be present on anterodorsal margin of head; postabdomen short, with 5-6 sharply pointed anal spines; claw without basal spine (Fig. 10); ephippial female with more rounded body, without head-horn; ephippium with single oval egg.

Male: Smaller than female (Fig. 11); body quadrangular in outline with straight dorsal margin; antennule longer than that of female, and with two sensory hairs (Fig. 12); first thoracic leg with a prehensile hook and a long flagellum emerging through the ventral margin of valves.

Size: Female: 0.55 x 0.41 mm, Male: 0.38 x 0.22 mm.

Remarks: *Ceriodaphnia cornuta* is widely distributed in the tropical and subtropical regions of the world. In India, it is known from West Bengal (Gurney 1906, Sharma 1978) Bihar (Nasar 1977), Rajasthan (Nayar 1971, Biswas 1971, Venkataraman 1992), Meghalaya (Patil 1976), Karnataka (Patil and Gouder 1988), Kerala (Michael and Sharma 1988), and West Bengal (Venkataraman and Das 2001). Males of *C. cornuta* are being reported for the first time from India.

4. ***Simocephalus latirostris*** Stingelin, 1906 (Figs 13-14)

This species was represented by 2 parthenogenetic females in a ditch near Kokkara wayal.

Female: Body with its maximum height behind middle (Fig. 13); head small separated from rest of body by a deep cervical sinus; snout projects ventrally forming a rostrum; vertex without spinules; valves ornamented with oblique striations forming a network, dorsal margin arched; ventral margin nearly straight; posterior margin slightly serrated, forming a blunt process; antennule longer than rostrum, sensory seta near its base; antennae reach only half the length of body; postabdomen broad with a prominent preanal angle, its dorsal margin with 6 anal spines increasing in size distally; claw long, without basal spine (Fig. 14).

Size: 1.30 x 0.88 mm.

Remarks: First report from Kerala State. *S. latirostris* is known to be a rare species, never occurring in large numbers. In India, this species was first reported by Biswas (1971) from Rajasthan and subsequently by Michael and Sharma (1988) from Tamil Nadu and Rajasthan.

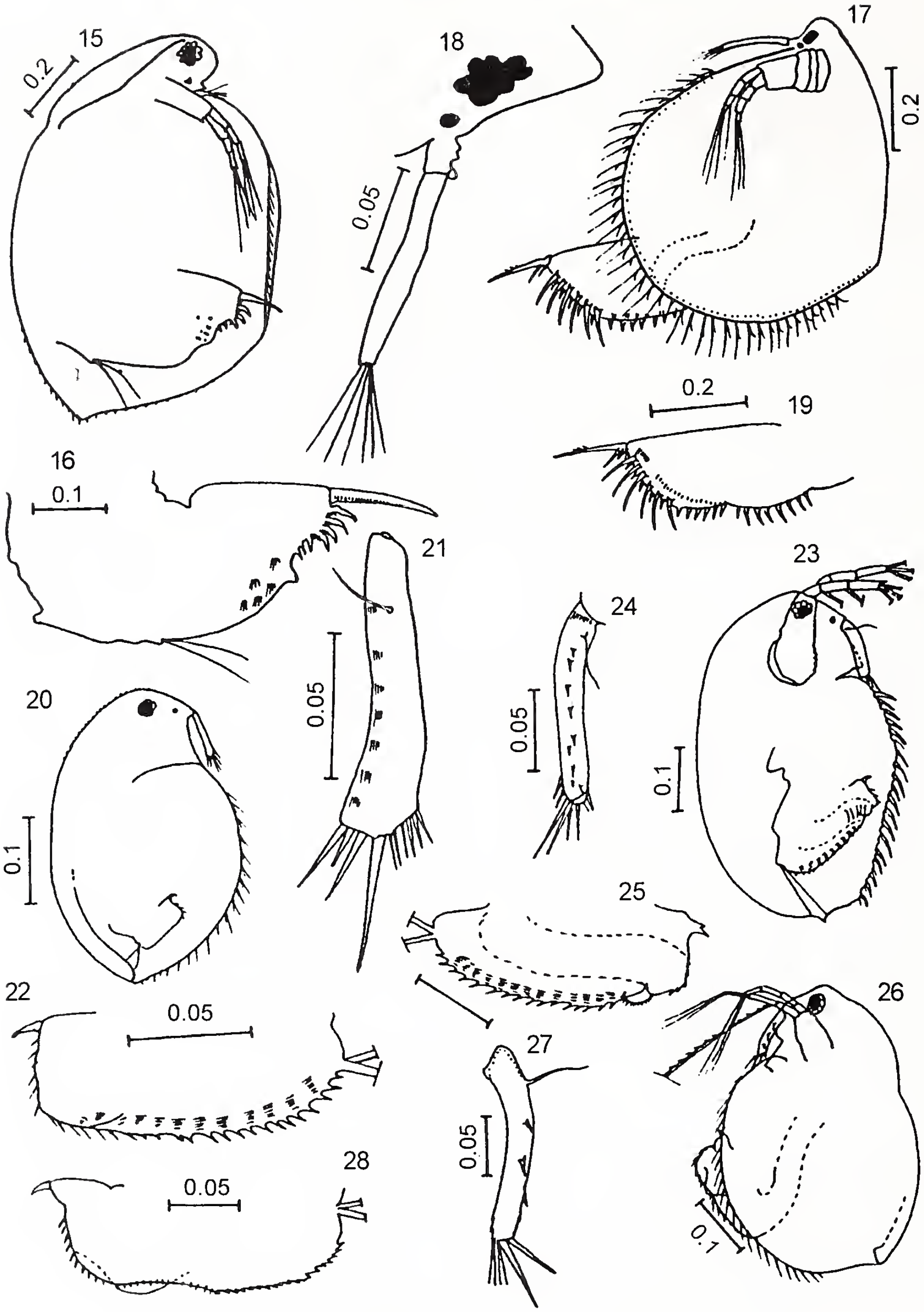
5. ***Simocephalus exspinosus*** (Koch, 1841) (Figs 15-16)

A large number of parthenogenetic females were present in a ditch adjacent to Periyar Lake.

Female: Body large, somewhat rhomboidal in outline (Fig. 15); head relatively small, with short rostrum; ocellus minute; shell forms a blunt protuberance at its posterior margin; posterior half of shell margin denticulate; valves ornamented with interconnected oblique striations. Antennule extends beyond tip of rostrum; postabdomen broad with acute preanal angle, 12-14 anal spines; claw long, pectinate, without basal spine (Fig. 16).

Size: 1.35 x 0.86 mm.

Remarks: First report from Kerala. *S. exspinosus* is



Figs 15-16: *Simocephalus exspinosus* (Koch); 15. Female, 16. Postabdomen;
Figs 17-19: *Ilyocryptus spinifer* Herrick; 17. Female, 18. Antennule, 19. Postabdomen of female;
Figs 20-22: *Macrothrix spinosa* King; 20. Female, 21. Antennule of female, 22. Postabdomen of female;
Figs 23-25: *Macrothrix triserialis* (Brady); 23. Female, 24. Antennule of female, 25. Postabdomen of female;
Figs. 26-28: *Macrothrix odiosa* (Gurney): 26. Female, 27. Antennule of female, 28. Postabdomen of female

known to be a cosmopolitan species. In India, it is reported from Meghalaya (Patil 1976), West Bengal (Sharma 1978; Michael and Sharma 1988; Venkataraman and Das 2001) and Karnataka (Patil and Gouder 1988). The specimens from Dharwad described by Patil and Gouder (1988) differ from the present specimens in having a prominent rhomboidal ocellus.

Family Ilyocryptidae Smirnov, 1976

6. ***Ilyocryptus spinifer*** Herrick, 1882 (Figs 17-19)

Five parthenogenetic females were obtained from a temporary water body at Periyar Tiger Reserve.

Female: Body shape characteristic with deeply arched ventral margin (Fig. 17); head small and tapering; ventral margin of valves with long, branched, plumose setae; antennule, bi-articulated proximal segment short, distal with a few terminal setae (Fig. 18); postabdomen bilobed, with about 25 marginal denticles and long anal spines; claw slender with 2 unequal basal spines (Fig. 19); anal aperture opens in the middle of postabdomen.

Size: 0.67 x 0.53 mm.

Remarks: Michael and Sharma (1988) reported this species at Thiruvananthapuram (Kerala) from the collections of D.G. Frey. It is also known to occur in West Bengal (Gurney 1907, Sharma 1978, Venkataraman and Das 2001), Rajasthan (Biswas 1971, Venkataraman 1992), Meghalaya (Patil 1976) and Karnataka (Patil and Gouder 1988).

Family Macrothricidae Norman & Brady, 1867

7. ***Macrothrix spinosa*** King, 1852 (Figs 20-22)

A common species, found in several samples from the lake and neighbouring sites.

Female: Body oval, without distinct cervical sinus (Fig. 20); head large with pointed rostrum; eye situated close to margin; ocellus minute; carapace with a blunt protuberance at its posterior margin; anterior dorsal margin minutely serrated; ventral margin with a series of long setae; antennule originates from tip of rostrum, distally expanded; lateral sensory seta near its base; a group of sensory papillae on its apex (Fig. 21); postabdomen short; dorsal margin with strong anal denticles and rows of minute lateral spinules; claw without basal spine (Fig. 22).

Size: 0.36 x 0.25 mm.

Remarks: First report from Kerala. Biswas (1971) and Venkataraman (1992) reported this species from Rajasthan, Patil (1976) from Manipur, Michael and Sharma (1988) from Tamil Nadu and Venkataraman and Das (2001) from W. Bengal.

8. ***Macrothrix triserialis*** (Brady, 1886) (Figs 23-25)

A good number of adult females and juveniles were collected from the lake.

Female: Body of adult female nearly oval (Fig. 23); head large, separated from rest of body by a conspicuous cervical depression; shell produced into a sharp angle posteriorly; ventral margin of valves with long bristles; antennule slender, cylindrical, armed with a series of small spinules and a few terminal setae (Fig. 24); postabdomen bilobed with several anteriorly directed denticles along its dorsal margin (Fig. 25); claw short without basal spine.

Size: 0.56 x 0.34 mm.

Remarks: Michael and Sharma (1988) reported this species from Irinjalakuda, Kerala from the collections of C.K.G. Nayar. Also known to occur in Bihar (Gurney 1907) Rajasthan (Biswas 1971, Michael and Sharma 1988), West Bengal (Michael and Sharma 1988, Venkataraman and Das 2001) and Karnataka (Patil and Gouder 1988).

9. ***Macrothrix odiosa*** (Gurney, 1907) (Figs 26-28)

A few parthenogenetic females were found in the samples from the lake.

Female: Body oval in outline (Fig. 26); head large, separated from trunk by a distinct cervical sinus; carapace with its posterior protuberance above the middle; valves without any characteristic ornamentation, their margins fringed with setae along whole length; antennule long, slender with a sensory seta near its base, a few short spinules and long terminal setae (Fig. 27); postabdomen large and bilobed (Fig. 28).

Size: 0.76 x 0.53 mm.

Remarks: First report from Kerala. Gurney (1907) reported this species from Bihar, Biswas (1971); Michael and Sharma (1988) from Rajasthan, and Patil and Gouder (1988) from Karnataka.

Family Moinidae Goulden, 1987

10. ***Moina micrura*** Kurz, 1874 (Figs 29-31)

Several parthenogenetic females and a few ephippial females were present in the lake plankton.

Female: Body small, thick and transparent (Fig. 29); head relatively large, with shallow supraocular depression; a distinct cervical sinus between head and trunk; valves transparent with reticulations and 20-24 spinules on ventral margin; surface of valves devoid of setules or hairs; antennule originates well behind eye; lateral sensory seta situated almost in the middle; antenna reaching only up to middle of valves when extended; postabdomen short, distally conical; with 5 feathered lateral spines and a distal bident tooth; claw long; ephippium saddle-shaped, hard, darkly pigmented, containing one egg.

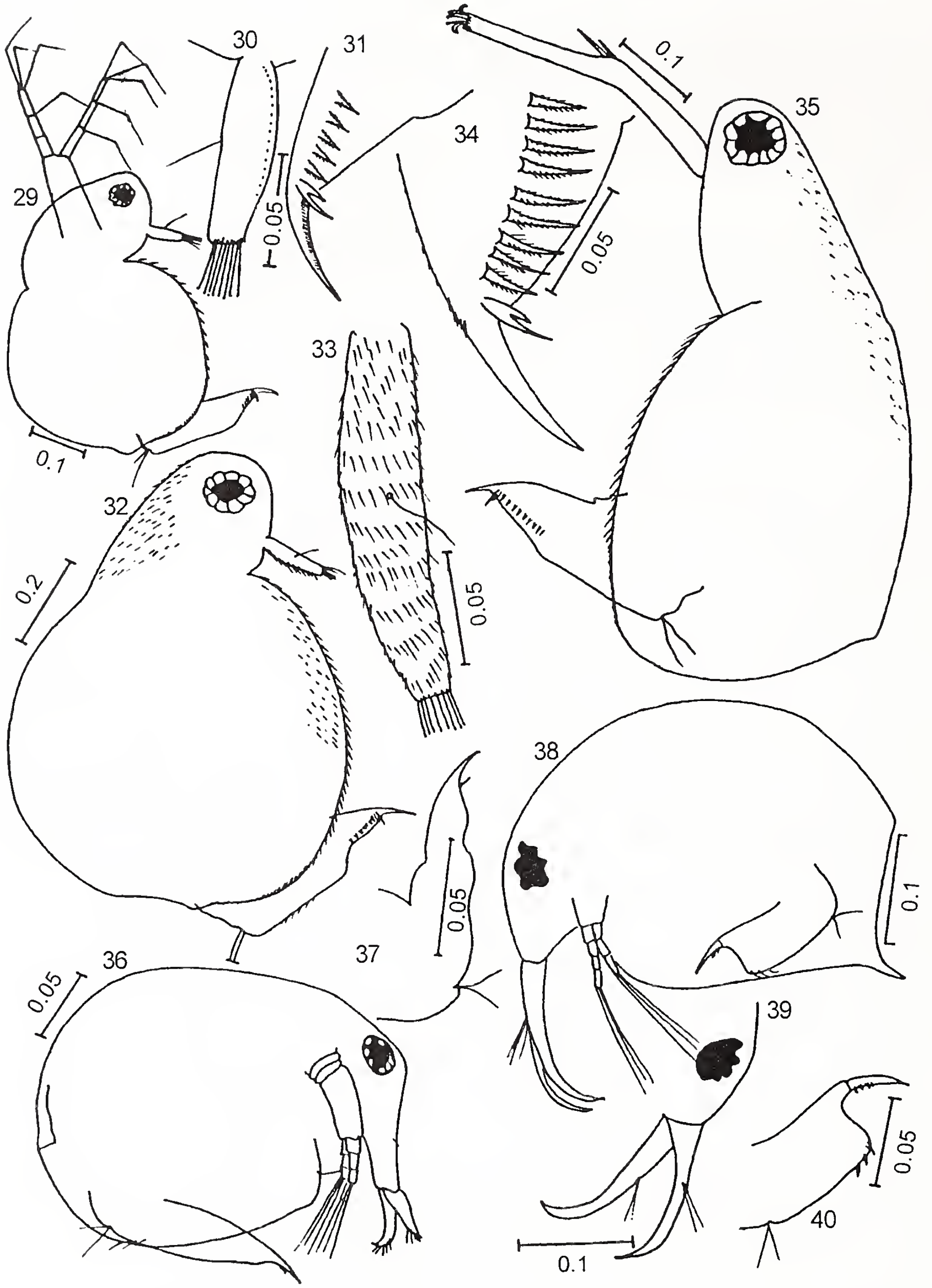
Size: 0.75 x 0.44 mm.

Remarks: *M. micrura* is widely distributed in India, known from West Bengal (Sewell 1935, Sharma 1978, Michael and Sharma 1988, Venkataraman and Das 2001), Tamil Nadu (Brehm 1936, Michael and Sharma 1988), Karnataka (Patil and Gouder, 1988), Rajasthan (Biswas 1971), Kerala (Michael and Sharma 1988, Raghunathan 1989).

11. ***Moina macrocopa*** (Straus, 1820) (Figs 32-35)

A sample obtained from a temporary water body at Periyar Tiger Reserve contained several parthenogenetic females, 3 ephippial females and 5 males of this species

Female: Large-sized forms (Fig. 32); head broadly rounded without supraocular depression; no ocellus; head and body covered with fine setules, setulation more dense towards dorsal half; valves granulated with faint reticulations



Figs 29-31: *Moina micrura* Kurz; 29. Female, 30. Antennule of female, 31. Anterior portion of female postabdomen;
Figs 32-35: *Moina macrocopa* (Straus); 32. Female, 33. Antennule of female, 34. Anterior portion of female postabdomen, 35. Male;
Figs 36-37: *Bosminopsis deitersi* Richard; 36. Female, 37. Postabdomen of female;
Figs 38-40: *Bosmina longirostris* (O.F. Muller); 38. Female, 39. Head with antennule, 40. Postabdomen of female.

formed by interconnected longitudinal lines; ventral margin armed with 80-90 small setae, followed by ungrouped setules; antennules large, covered by hairs and setules; lateral sensory seta near the middle (Fig. 33). Antenna stout and hairy; first thoracic leg of female distinct in having teeth on the ventral margin of the penultimate segment of anterior seta; postabdomen large with 9 long feathered lateral spines and a distal bident tooth, claw pectinate (Fig. 34). Ephippial females smaller than parthenogenetic females; setules absent on head and valves; ephippium saddle-shaped, ornamented with polygonal markings, contains 2 eggs.

Male: Smaller than female (Fig. 35); head and trunk densely covered by hairs; antennules very long, bent at middle; 2 lateral setae of unequal length; 5 terminal hooks; first thoracic leg of male distinct, with large recurved hooks on penultimate segment; postabdomen similar to that of female.

Size: **Female**: 1.06 x 0.65 mm, Male: 0.65 x 0.36 mm.

Remarks: First report from Kerala. Goulden (1968) considers *Monia easu* Brehm, 1936 from Nilgiri Hills Tamil Nadu and *Moina ganapati* Brehm, 1963 from River Yamuna, Delhi as synonyms of *M. macrocopa*.

Family Bosminidae Sars, 1865

12. ***Bosminopsis deitersi*** Richard, 1875 (Figs 36-37)

A few parthenogenetic females in the lake plankton represented this species.

Female: Minute form with oval body, maximum height behind middle (Fig. 36); head with long rostrum forming proboscis-like structure; valves ornamented with reticulations; posterior corner rounded. Antennules united at their bases, diverge distally carrying a few terminal setae; postabdomen tapering distally; claw with prominent basal spine (Fig. 37).

Size: 0.28 x 0.20 mm.

Remarks: Michael and Sharma (1988) reported this species at Irinjalakuda, Kerala from the collections of C.K.G. Nayar. They differ from Thekkady specimens in having a small mucronate process and a few spinules on the posteroventral corner of the valves. Patil and Gouder (1988) had one form with 2 spines and another with a single spine on the posteroventral corner of the valves. Idris (1983) observed a long and sharply pointed marginal spine on the posteroventral corner in his collections from Malaysia. These observations indicate that this is a variable character in *B. deitersi*.

13. ***Bosmina longirostris*** (O.F. Muller, 1776) (Figs 38-40)

A few specimens of this species were obtained from a small ditch in the Periyar Tiger Reserve.

Female: Body transparent with an arched dorsal margin; posterior margin straight; posteroventral corner produced into a conspicuous backwardly directed spine (Fig. 38); head large, smoothly arched in front of eye; antennules long, parallel to each other, terminally bent backwards; olfactory setae nearer to the base than to tip of the antennule (Fig. 39); antenna small with 3-segmented dorsal ramus and 4-segmented ventral ramus; postabdomen quadrate with 3 anal spines; claw with a proximal pecten of 4 spinules (Fig. 40).

Size: 0.41 x 0.29 mm.

Remarks: First report from Kerala. Brehm (1936) reported this species from Dal Lake, Kashmir; Yousuf and Quadri (1977) from Malpur Sar, Kashmir; Sharma (1978), Venkataraman and Das (2001) from West Bengal; Patil (1976) from Meghalaya, and Michael and Sharma (1988) from Madhya Pradesh, West Bengal and Meghalaya.

Family Chydoridae Stebbing, 1902

Sub-Family Chydorinae Stebbing, 1902

14. ***Picripleuroxus similis*** (Vavra, 1900)

(=*Pleuroxus similis* Vavra, 1900). (Figs 41-43)

A few female specimens were obtained from a ditch near Kokkara wayal, Thekkady.

Female: Carapace with evenly arched dorsal margin, straight posterior margin and without any ornamentation; ventral margin of valves with feathered setae; posteroventral corner produced into a blunt spine (Fig. 41); head with long pointed rostrum curved backwards; labrum with convex anterior margin and rounded ventral margin (Fig. 42); antennules short, never reaching tip of rostrum; postabdomen slightly tapering distally, 9-10 anal spines; claw with 2 unequal basal spines, proximal shorter (Fig. 43).

Size: 0.44 x 0.30 mm.

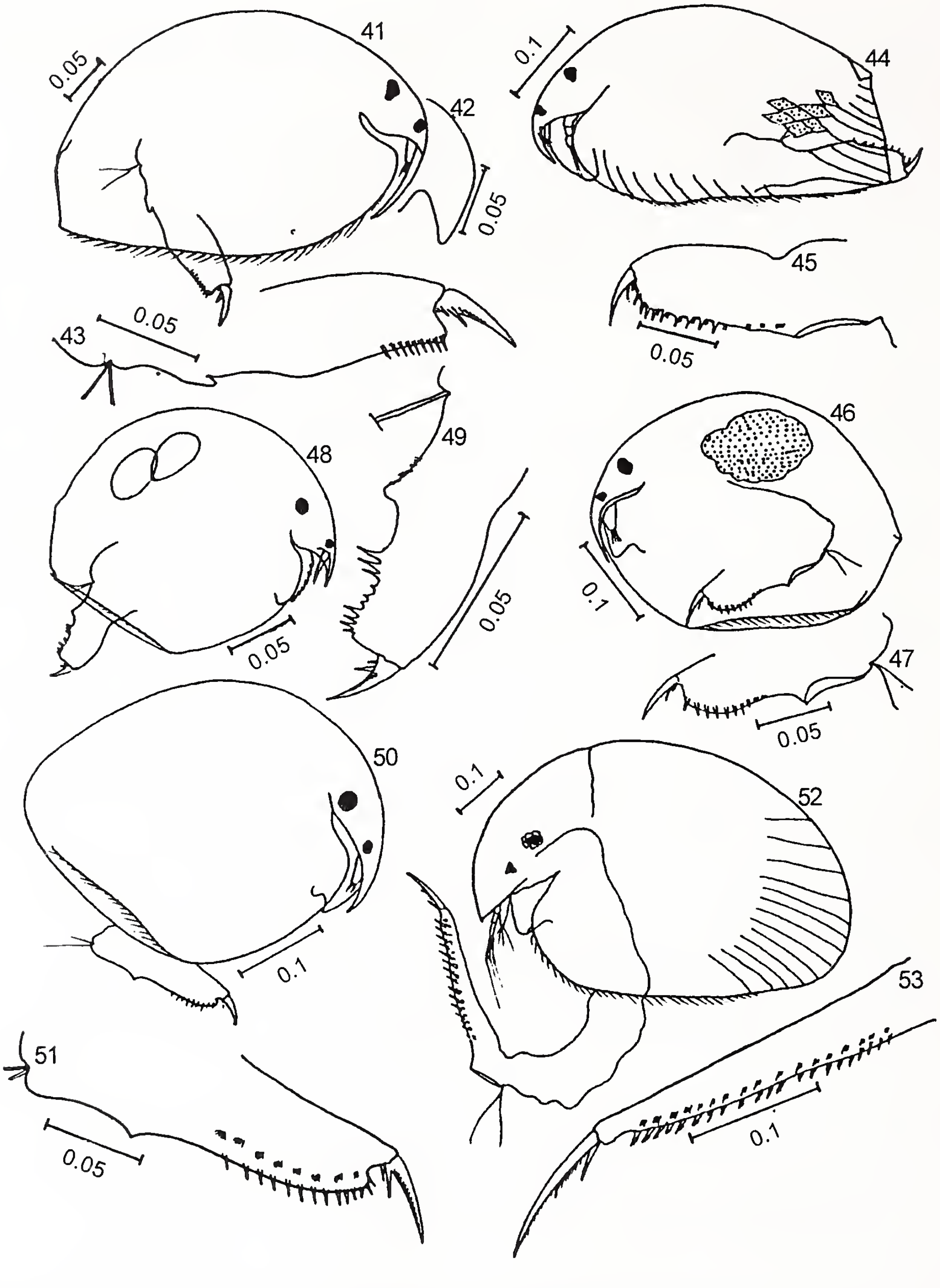
Remarks: Frey (1993) suggested the generic name '*Picripleuroxus*' for much elongated animals with elongated postabdomen. The present species can be distinguished from the closely related *Pleuroxus trigonellus* (O.F. Muller) by the presence of non-reticulated valves. The number of anal spines is found to be a variable character in Thekkady specimens. Yousuf and Quadri (1977), and Quadri and Yousuf (1978) reported this species from Kashmir. Other Indian reports include Sharma (1978) and Venkataraman and Das (2001) from West Bengal, Michael and Sharma (1988) from Shillong, Venkataraman (1992) from Bharatpur, Rajasthan. The present report is the first from Kerala.

15. ***Alonella clathratula*** Sars, 1896 (Figs 44-45)

Several parthenogenetic females were present along with *Picripleuroxus similis* in the samples collected from a ditch near Kokkara wayal, Thekkady.

Female: Body somewhat elongated and oval, with slightly arched dorsal margin and straight posterior margin, which is more than half of the maximum body height (Fig. 44); valves ornamented with polygons with longitudinal striations and stipples; ventral margins of valves with plumose setae along whole length; head relatively small with long pointed curved rostrum; antennule small, reaching middle of rostrum; labrum rounded anteriorly with a shallow notch at its apex; postabdomen with distinct preanal angle; 9 anal spines and a few setules; claw of moderate size with 2 basal spines of unequal size (Fig. 45).

Size: 0.32 x 0.22 mm.



Figs 41-43: *Picripleuroxus similis* (Vavra); 41. Female, 42. Plate of labrum, 43. Postabdomen of female;
Figs 44-45: *Alona clathratula* Sars; 44. Female, 45. Postabdomen of female;
Figs 46-47: *Chydorus eurynotus* Sars; 46. Female, 47. Postabdomen of female;
Figs 48-49: *Ephemeroporus barroisi* (Richard); 48. Female, 49. Postabdomen of female;
Figs 50-51: *Chydorus ventricosus* Daday; 50. Female, 51. Postabdomen of female;
Figs 52-53: *Camptocercus uncinatus* Smirnov; 52. Female, 53. Anterior portion of Postabdomen

Remarks: Although the present species is similar to *A. excisa*, its body and postabdomen are more elongated and more similar to *A. clathratula*. In *A. clathratula* the valves are ornamented with granulated polygons and longitudinal striations while in *A. excisa* the polygons are not granulated. Moreover, in *A. clathratula* the labrum has a slight depression at its anteroventral end. *A. clathratula* is reported for the first time from India.

16. *Chydorus eurynotus* Sars, 1901 (Figs 46-47)

Present in the plankton samples collected from the lake.

Female: Body somewhat spherical, with distinct posterodorsal corner (Fig. 46); valves without markings; dorsal margin more arched than ventral margin; posteroventral margin characteristic with a double contour margin and a row of plumose setae on inner margin; head shield broadly rounded posteriorly and pointed anteriorly; rostrum long with pointed apex; antennule small, reaching half way to tip of rostrum; postabdomen with distinct pre-anal corners (Fig. 47); dorsal margin of postabdomen armed with 9 anal spines and claw with two unequal basal spines.

Size: 0.36 x 0.27 mm.

Remarks: First report from Kerala. Earlier reports in India are those of Nayar (1971) and Venkataraman (1990) from Rajasthan, and Battish (1981) from Punjab.

17. *Ephemeroporus barroisi* (Richard, 1894) (Figs 48-49)

Large numbers of parthenogenetic females were collected from a lake.

Female: Body with arched dorsal margin, with maximum height in the middle (Fig. 48); posterior margin straight and short with posterodorsal angle and short spine at posteroventral corner; ventral margin forms a broad angle in the middle and is setulated posteriorly; valves ornamented with polygonal cell markings; rostrum short, pointed and directed downwards; ocellus much smaller than eye, situated at half the length of rostrum; antennule reaches about half the length of the rostrum; labrum characteristic with serrated anterior margin having 5-6 teeth and a bluntly pointed ventral margin; postabdomen relatively short with prominent preanal corner and 9-10 anal spines of unequal length (Fig. 49); claw with two basal spines, of which proximal one much shorter than the distal.

Size: 0.27 x 0.18 mm.

Remarks: First report from Kerala. The present specimen agrees with the description given by Smirnov (1996). Michael and Sharma (1988) recorded this species from Thiruvananthapuram from the collections of D.G. Frey. It is also known from Gujarat (Petkovski 1966) and West Bengal (Sharma 1978; Venkataraman and Das 2001).

18. *Chydorus ventricosus* Daday, 1898 (Figs 50-51)

Female specimens collected from littoral weedy margin of lake.

Female: Body somewhat oval, with rounded posterodorsal and posteroventral corners; ventral margin strongly bulging outwards at the middle; posteroventral margin with double line (Fig. 50); valves ornamented with faint wavy hexagonal markings; rostrum long, pointed and slightly bent backwards; antennules reach about half the length of rostrum; postabdomen long, tapering with distinct pre-anal, post-anal corners and with 12-14 anal spines (Fig. 51); claw setulated with 2 basal spines of unequal length.

Size: 0.5 x 0.31 mm.

Remarks: This species was reported from Kerala by Michael and Sharma (1988) from Thiruvananthapuram and Irinjalakuda, Ragunathan (1989) from Wynaad. It is also recorded in Nilgiri Hills, Tamil Nadu (Brehm 1936) Gujarat (Petkovski 1966), Rajasthan (Biswas 1971, Michael and Sharma 1988), and West Bengal (Venkataraman and Das 2001).

Sub-Family Aloninae Frey, 1967

19. *Camptocercus uncinatus* Smirnov, 1991 (Figs 52-53)

Two mature females were obtained from Kokkara wayal ditch, Thekkady.

Female: Body nearly oval, with arched dorsal and almost straight ventral margin, with series of setae (Fig. 52); maximum height slightly anterior to the middle of the body; postero-ventral corner rounded and smooth, without denticles; valves ornamented with several longitudinal parallel lines; rostrum broad and slightly pointed; ocellus smaller than eye, situated nearer to the eye than to the tip of rostrum; antennule almost reaching the tip of rostrum; postabdomen very long, narrow, with about 20 anal denticles; claw with large basal spine (Fig. 53).

Size: 0.68 x 0.47 mm.

Remarks: The specimens agree with the description by Smirnov (1974). This is the first report from India.

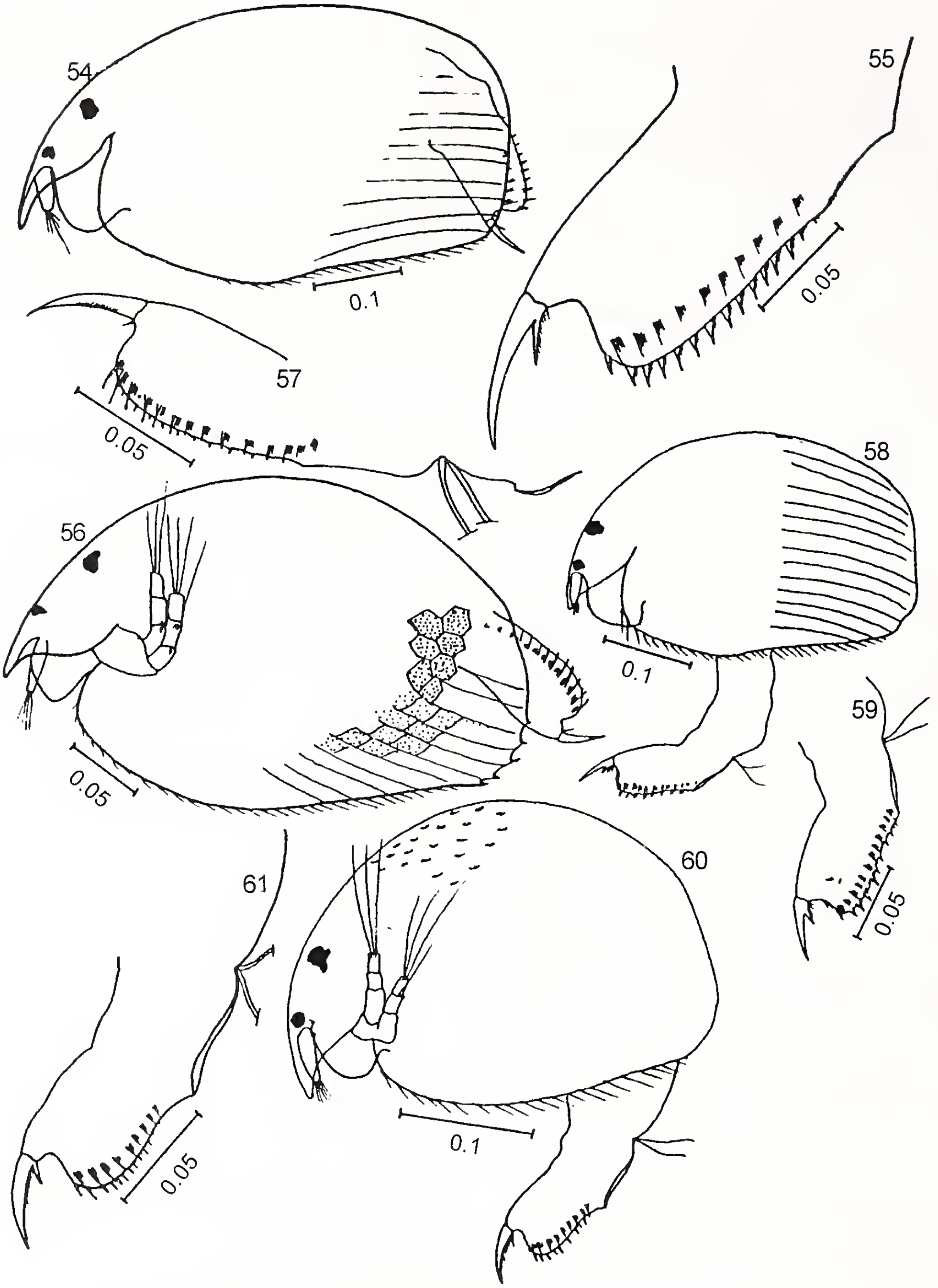
20. *Biapertura affinis* (Leydig, 1860) (Figs 54-55)

A few specimens collected from among the weeds of Kokkara wayal ditch, Thekkady.

Female: Body oblong with arched dorsal margin, nearly straight setulated ventral margin and rounded posterodorsal and posteroventral corners (Fig. 54); valves with longitudinal striations that are more distinct towards posterior and ventral margins; head shield with pointed posterior margin and two median head pores with narrow connection between them, in addition to two lateral pores situated one on either side of the anterior pore; rostrum blunt and antennules not reaching the apex of rostrum; labrum evenly rounded anteriorly, somewhat pointed ventrally; postabdomen of almost uniform width, with about 15 anal denticles and about 10 groups of lateral setae (Fig. 55); claw long with single basal spine.

Size: 0.62 x 0.34 mm.

Remarks: First report from Kerala. In India, this species is known from Kashmir (Brehm 1936), Gujarat (Petkovski 1966), West Bengal (Sharma 1978, Michael and Sharma 1988) Meghalaya (Michael and Sharma 1988) and Punjab (Battish 1992).



Figs 54-55: *Biapertura affinis* (Leydig): 54. Female, 55. Postabdomen of female;
Figs 56-57: *Biapertura karuva* (King): 56. Female, 57. Postabdomen of female;
Figs 58-59: *Biapertura intermedia* Sars: 58. Female, 59. Postabdomen (female);
Figs 60-61: *Biapertura verrucosa* (Sars): 60. Female, 61. Postabdomen (female)

21. ***Biapertura karuva*** (King, 1852) (Figs 56-57)

Female specimens were collected from the lake near the boathouse.

Female: Body of female with evenly arched dorsal margin, its maximum height being a little behind the middle of the body (Fig. 56); valves with rounded posteroventral corners, with about 5 denticles which is characteristic of the species; valves ornamented with oblique parallel striations and polygon markings; rostrum blunt, antennules almost reaching its apex; postabdomen broadly rounded, distal dorsal margin armed with 8-10 anal denticles and 11-13 groups of lateral setae that may extend beyond its dorsal margin (Fig. 57); claw with very short basal spine.

Size: 0.36 x 0.23 mm.

Remarks: First report from Kerala. The number of denticles on the posteroventral corner of the carapace varies from 1-5. In India, this species was reported from West Bengal (Sharma 1978, Venkataraman and Das 2001), Meghalaya (Patil 1976), Tamil Nadu (Michael and Sharma 1988), Rajasthan (Venkataraman 1990) and Punjab (Battish 1992).

22. ***Biapertura intermedia*** Sars 1862 (Figs 58-59)

Seven parthenogenetic females were obtained from the weeds collected from the lake.

Female: Body sub-quadrate with rounded posterodorsal and posteroventral corners; dorsal margin of carapace arched, ventral margin straight with series of setae (Fig. 58); valves ornamented with parallel lines; rostrum blunt, antennule not reaching apex of rostrum. Postabdomen with rounded distal corner, armed with 8 anal denticles decreasing in size proximally and 10-11 groups of lateral setae; with single basal spine (Fig. 59).

Size: 0.38 x 0.25 mm.

Remarks: The present species is reported for the first time from India.

23. ***Biapertura verrucosa*** (Sars, 1901) (Figs 60-61)

This species is common among the littoral weeds of the lake.

Female: Body with arched dorsal margin, setulated ventral margin, maximum height at the middle (Fig. 60); valves with rounded posteroventral and evenly rounded posterodorsal margins; valves ornamented with characteristic tubercles or verrucae, more distinct interiorly; rostrum blunt, antennule hardly reaching apex of rostrum; postabdomen with distinct pre-anal and post-anal corners, dorsal margin armed with 9-11 anal denticles and 9-10 groups of lateral setae; claw with single basal spine (Fig. 61).

Size: 0.32 x 0.23 mm.

Remarks: The species was reported from Gujarat (Petkovski 1966), Rajasthan (Nayar 1971, Venkataraman 1990, Michael and Sharma 1988) and West Bengal (Venkataraman and Das 2001).

CONCLUSION

The occurrence of 23 species of Cladocera, based on a few random collections, indicates the richness of Cladoceran fauna in this high altitude lake. Of the 23 species, 15 species are recorded for the first time from Kerala State. The present study indicates that an extensive survey of different freshwater habitats will definitely add more species to the freshwater cladoceran fauna of Kerala.

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NOTES ON CALLIPHORID FLIES (DIPTERA: CALLIPHORIDAE) FROM SUNDARBANS BIOSPHERE RESERVE AND THEIR IMPACT ON MAN AND ANIMALS[1]

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Systematic accounts of nine species of calliphorid flies, their impact on man and animals, and distributional records from India are given. A new species *Chrysomya indica* is described and illustrated.

Key words: Diptera, systematic accounts, impacts, Sundarbans Biosphere Reserve

INTRODUCTION

Very little is known about the calliphorid flies from Sundarbans Biosphere Reserve except from the works of Mazumder and Parui (2001), and Sinha and Nandi (2002) who reported two species from this area. These flies are important in medical, veterinary and forensic sciences. They carry bacteria, viruses, protozoa and helminths that cause enteric diseases in man and other animals. Some larvae are parasites on earthworms, snails, toads, frogs, nestlings of birds and livestock, while a few cause huge loss in productivity of the dried-fish industry. Some larvae are useful in forensic investigations (Smith 1986) and for the treatment of osteomyelitis. Some are obligate parasites in living tissues and cause malign tissue myiasis in man and animals (Pont 1980).

MATERIAL AND METHODS

These flies were collected from different parts of Sundarbans Biosphere Reserve with the help of butterfly nets from different habitats like dried and semi-dried fish, crabs and prawns, dead molluscs, decaying garbage, excreta of different animals, fruits and flowering plants in different seasons, as well as meat shops. The flies were then killed in jars using benzene vapour, transferred to a small tissue paper envelope and preserved dry therein. The chaetotaxy was studied using a stereoscopic dissecting microscope. The male genitalia were pulled out with a fine forceps and dissected in cavity block using a stereoscopic dissecting microscope. The dissected parts were dehydrated through alcoholic grades and figures were drawn with the help of Camera Lucida where required. The genitalia were preserved in a small triangular paper board and attached with the respective species specimens. A total of nine species belonging to four genera were found. The taxonomic classification of Rognes (1991) was followed.

Holotype and 2 ♂♂ Paratypes are deposited in the National Collection of Zoological Survey of India, Kolkata. Regn No. 8637/H6.

Systematic accounts

Subfamily: Calliphorinae

Tribe: Calliphorini

1. ***Calliphora* (*Calliphora*) *vicina*** Robineau-Desvoidy

1830, *Calliphora vicina* Robineau-Desvoidy, *Mém. pres. div. Sav. Acad. Sci. Inst. Fr. (2)2*: 435.

2000, *Calliphora* (*Calliphora*) *vicina*: Nandi, *Rec. zool. Surv. India 98(4)*: 1.

Specimens examined: 2♂♂, Ghoramara Island, 4.xi.1999.

Impact on man and animals: This species is mostly found on dead animals, including human corpses and faeces, and is closely associated with man. The adult flies are biologically associated with polio virus, *Escherichia*, *Aerobacter*, *Proteus*, *Flavobacterium*, *Salmonella*, *Shigella*, *Staphylococcus*, *Streptococcus*, *Bacillus*, *Leptospira*, *Herpetomonas*, *Chilomastix*, *Entamoeba*, *Eimeria*, *Toxoplasma*, *Endolimax* and *Giardia intestinalis*, *Mycobacterium tuberculosis*, *Trichuris trichura*, *Ascaris lumbricoides* and *Vibrio comma* (Greenberg 1971). The larvae cause intestinal and urinary myiasis in humans (James 1947). They are also helpful in forensic science, in detecting the approximate time of death (Smith 1986).

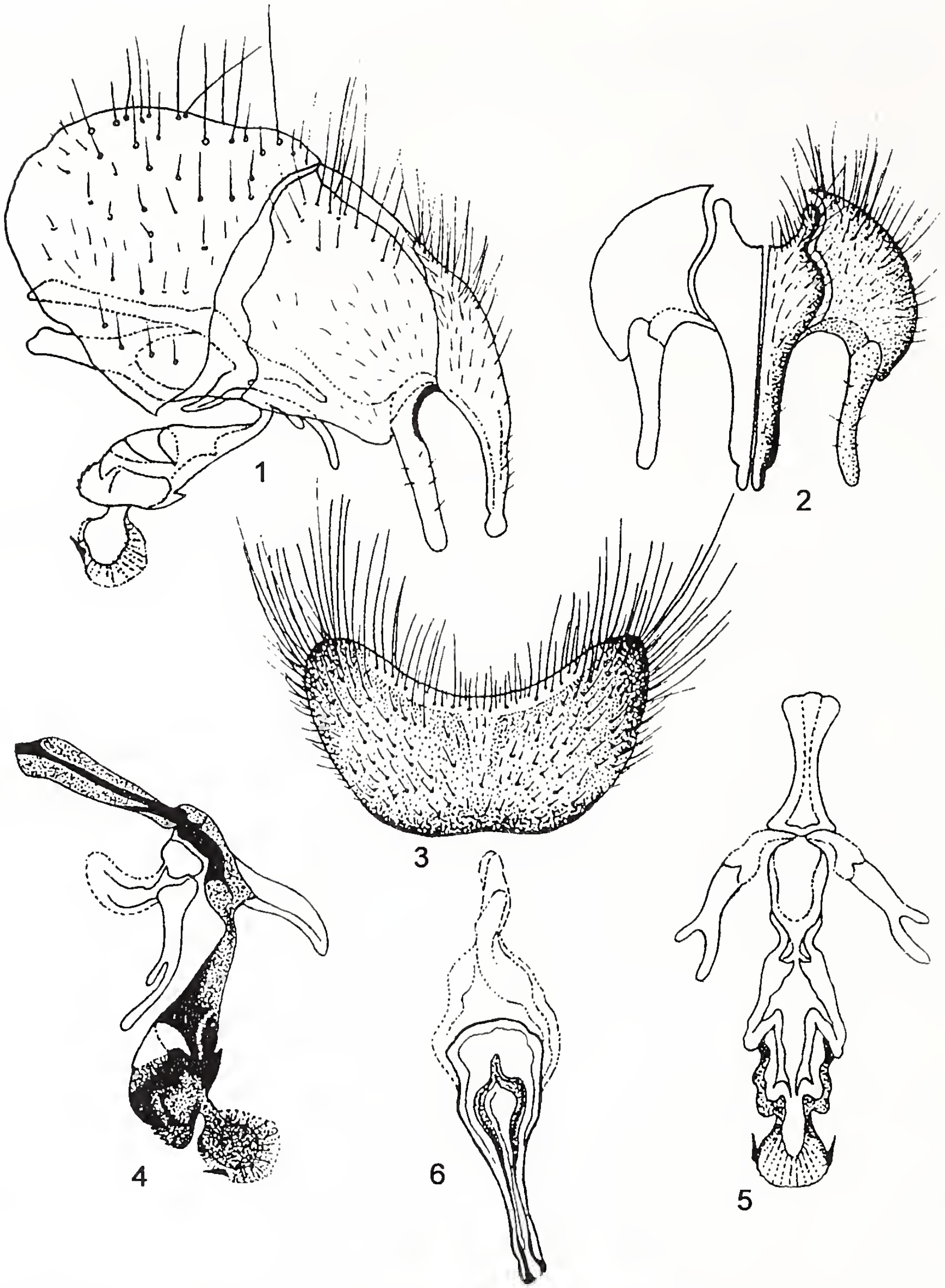
Distribution: West Bengal (Alipurduar, Birpara, Darjeeling, Ghoramara Island, Kalimpong, Kurseong, Rajabhatkhawa), Himachal Pradesh (Shimla), Sikkim (Mangan, Phensang) and Uttaranchal (Nainital).

Subfamily: Luciliinae

Tribe: Luciliini

2. ***Hemipyrellia ligurriens*** (Wiedemann)

1830, *Musca ligurriens* Wiedemann, *Aussereurop. zweifl. Insekt. 2*: 655.



Figs 1-6: *Chrysoma indica* sp. nov.; 1. Epandrium, inner and outer forceps and phallosome (lateral view), 2. Inner and outer forceps (posterior view), 3. Fifth sternite of male, 4. Phallosome, anterior and posterior parameres (lateral view), 5. Phallosome, anterior and posterior parameres (ventral view), 6. Ejaculatory duct

2000, *Hemipyrellia ligurriens*: Nandi, *Rec. zool. Surv. India 98(4)*: 3.

Specimens examined: 1 ♂, Ganga Sagar (Sagar Island), 20.viii.2000; 1 ♂, Narayanpur, 16.iv.2000; 2 ♂♂, Bhagabatpur, 18.x.2000.

Impact on man and animals: This scavenger is mostly found on carcasses and human excrement. The adult flies are regarded as the most potential vectors of enteric pathogens, as they visit both human food for consumption and excrement. The larvae with parasitic adaptation are able to utilize pre-existing wounds under laboratory conditions (Roy and Dasgupta 1971) and different animals.

Distribution: West Bengal (Bhagabatpur, Bijanbari, Budge Budge, Burdwan, Buxa, Ganga Sagar, Kalimpong, Kalyani, Kolkata, Madarihat, Narayanpur, Ranaghat, Shibpur, Siliguri, Sukna Forest), Bihar (Purnea), Sikkim (Phensang, Swistik Camp) and Tamil Nadu (Chennai).

3. ***Lucilia* (*Lucilia*) *cuprina*** (Wiedemann)

1830, *Musca cuprina* Wiedemann, *Aussereurop. zwiefl. Insekt, 2*: 654.

2002, *Lucilia* (*Lucilia*) *cuprina* Nandi, *Rec. zool. Surv. India 100 (1-2)*: 121.

Specimens examined: 4♂♂, Bani Jungle (Sagar Island), 31.i.2000; 15♂♂, Ganga Sagar (Sagar Island), 1.ii.2000; 1♂, Dhabalhat Shibpur (Sagar Island), 31.i.2000; 7♂♂, Jambu Island, 16.ii.2001.

Impact on man and animals: A scavenger, it is mostly available on carcasses. The adults are associated with *Escherichia coli*, *Proteus mirabilis*, *Proteus morganii*, *Proteus rettgeri*, *Proteus vulgaris* and *Ascaris lumbricoides*, and may cause dysentery in humans. They also carry *Morganella* sp. (Kano and Shinonaga 1968). The larvae cause external myiasis in sheep, toad and wound myiasis in man. They are obligate parasites in living tissue and may cause malign tissue myiasis in man. This species is the notorious sheep maggot of Australia and causes extensive loss in sheep farming. This species is suspected to transmit poliomyelitis virus to human beings (Rognes 1991).

Distribution: West Bengal (Alipurduar, Bani Jungle, Dhabalhat Shibpur, Ganga Sagar, Jaigaon, Jambu Island, Kalyani, Rajabhatkhawa, Ranaghat, Sealdah) and cosmopolitan distribution in India.

4. ***Lucilia* (*Lucilia*) *papuensis*** Macquart

1842, *Lucilia papuensis* Macquart, *Mém. Soc. Sci. Agric. Lille 2(3)*: 298.

1997, *Lucilia (Lucilia) papuensis* Nandi and Bhattacharya, *J. Beng. Nat. Hist. Soc. 16(2)*: 23.

Specimens examined: 3♂♂, Kakdwip, 12.ix.2000; 1♂, Bamankhali (Sagar Island), 31.i.2000; 3♂♂, Krishnagar (Sagar Island), 24.viii.2000.

Impact on man and animals: This species is frequently attracted to decaying animal matter, particularly dead earthworms. James (1971) recorded it from marsupial skull and human excrement.

Distribution: West Bengal (Kakdwip, Bamankhali, Krishnagar, Shibpur, Rajabhatkhawa, Ranaghat), Sikkim (Jorthang), Assam (Sadiya), Arunachal Pradesh (Pasighat), Himachal Pradesh (Shimla), Jammu & Kashmir (Gulmarg) and Kerala (Thiruvananthapuram).

5. ***Lucilia* (*Lucilia*) *porphyrina*** (Walker)

1856, *Musca porphyrina* Walker, *J. Proc. Linn. Soc. Lond. Zool. 1*: 24.

2000, *Lucilia* (*Lucilia*) *porphyrina* Nandi, *Rec. zool. Surv. India 98(4)*: 4.

Specimens examined: 2♂♂, Dhabalhat Shibpur (Sagar Island), 31.i.2000.

Impact on man and animals: A scavenger, it is attracted to carcasses of mammals, birds and reptiles. The adult is biologically associated with *Herpetomonas muscarum* and *Leptomonas mirabilis* and could cause harm to humans (Greenberg 1971).

Distribution: West Bengal (Burdwan, Coochbehar, Dhabalhat, Shibpur, Rajabhatkhawa, Ranaghat, Shibpur Botanical Garden), Assam (Sadiya), Arunachal Pradesh (Pasighat), Himachal Pradesh (Shimla), Jammu & Kashmir (Gulmarg) and Sikkim (Jorethang).

6. ***Lucilia* (*Lucilia*) *sericata*** (Meigen)

1826, *Musca sericata* Meigen, *Syst. Beschr. Europ. zweifl. Insekt. 5*: 53.

1997, *Lucilia* (*Lucilia*) *sericata* Nandi, *J. Beng. Nat. Hist. Soc. 16(2)*: 67.

Specimens examined: 2♂♂, Bamankhali (Sagar Island), 1.ii.2000; 1♂, Ghoramara Island, 4.xi.1999; 1♂, Ganga Sagar (Sagar Island), 20.viii.2000.

Impact on man and animals: This is a synanthropic species, and mostly available near human dwellings. Greenberg (1971) reported its biological association with polio virus, Coxsackie virus, *Proteus*, *Flavobacterium*, *Aerobacter*, *Serratia*, *Enterococcus*, *Pneumonia*, *Salmonella*, *Shigella*, *Herpetomonas*, *Clostridium*, *Staphylococcus*, *Streptococcus*, *Bacillus*, *Escherichia*, *Leptospira*, *Crithidia*, *Entamoeba*, *Toxoplasma*, *Trichuris*, *Ancylostoma*, *Mycobacterium* and *Ascaris*. They also carry *Morganella* sp. (Kano and Shinonaga 1968). The larvae cause wound myiasis in man and other animals, and are serious pests of sheep in Africa, Britain, Europe and Australia, causing myiasis, an important economic and welfare problem in many areas (Fisher *et al.* 1998). The larvae have been used in surgical cases (Stewart 1934) and have forensic importance as they help to detect the approximate time of death of a person.

Distribution: West Bengal (Bamankhali, Darjeeling, Ganga Sagar, Ghoramara Island, Kalimpong, Malda, Siliguri, Sukna, Takvar).

Subfamily: Chrysomyinae

Tribe: Chrysomyini

7. ***Chrysomya megacephala*** (Fabricius)

1794, *Musca megacephala* Fabricius, *Ent. Syst. 4*: 317.

2000, *Chrysomya megacephala* Nandi, *Rec. zool. Surv. India 98(4)*: 4.

Specimens examined: 1♂, Jambu Island, 1.ii.1999; 12♂♂, Ganga Sagar (Sagar Island), 1.ii.2000; 7♂♂, Dhabalhat Shibpur (Sagar Island), 31.i.2000; 8♂♂, Kakdwip, 3.xi.1999; 6♂♂, Kakdwip, 16.iv.2000; 3♂♂, Namkhana, 16.iv.2000; 3♂♂, Bhagabatpur, 19.x.2000, 4♂♂, Mohisani Island, 12.xi.2000; 1♂, Canning, 7.ii.2000; 11♂♂, Fraserganj, 17.iv.2000; 1♂, Chandanpiri, 20.x.2000; 4♂♂, Ganga Sagar (Sagar Island), 1.ii.2000; 2♂♂, Lothian Island, 18.x.2000.

Impact on man and animals: A synanthropic species, it is available on dead fish, sweets, carcasses, human excrement and fruits. The adult flies are vectors of infectious diseases of the digestive tract and have been reported to carry *Morganella* sp., which causes summer diarrhoea. Greenberg (1971) reported its biological association with polio virus, *Escherichia coli*, *Proteus mirabilis*, *Proteus morganii*, *Proteus rettgeri*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella dysenteriae*, *Leptomonas mirabilis*, *Chilomastix mesnili*, *Giardia intestinalis*, *Trichomonas hominis*, *Endolimax nana*, *Entamoeba coli*, *Entamoeba histolytica*, *Iodamoeba bütschlii*, *Hymenolepis diminuta*, *Trichuris trichiura*, *Ancylostoma duodenale* and *Ascaris lumbricoides*. He also reported it as vector of enteric pathogens in malnourished individuals living under unsanitary conditions. Its forensic importance has been mentioned by Smith (1986), and Wells and Kurahashi (1994). In Southeast Asia, these larvae are parasitic on semi-dried and dried fish, causing a major problem in the fish industry (Esser 1991). It is a secondary myiasis producer in man and domestic animals.

Distribution: West Bengal (Alipurduar, Bhagabatpur, Bijanbari, Canning, Chandanpiri, Dhabalhat Shibpur, Diamond Harbour, Digha, Fraserganj, Ganga Sagar, Jaigaon, Jainti, Jambu Island, Kakdwip, Kalyani, Kolkata, Kurseong, Malda, Mohisani Island, Namkhana, Panitanki, Rajabhatkhawa, Ranaghat, Shibpur, Shingla Bazar, Siliguri, Sukna) and almost throughout India.

8. ***Chrysomya rufifacies*** (Macquart)

1842, *Lucilia rufifacies* Macquart, *Mém. Soc. Sci. Agric. Lille 2(3)*: 303.

2000, *Chrysomya rufifacies* Nandi, *Rec. zool. Surv. India 98(4)*: 4.

Specimens examined: 1♂, Bamankhali (Sagar Island), 21.x.2000: 2♂♂. Chandanpiri, 20.x.2000; 2♂♂, Begnakhali, 13.ii.2001; 1♂, Ghoramara Island, 4.xi.1999.

Impact on man and animals: This synanthropic saprophage is attracted to carcasses. The adults are biologically associated with *Bacillus* sp., *Mycobacterium tuberculosis*, *Leptomonas mirabilis* and *Taeniarhynchus saginatum* (Greenberg 1971). The larvae are primarily scavengers and have been successfully used for treating osteomyelitis (James 1947). It produces secondary myiasis in humans and other animals. It is one of the main pests of sheep in Australian region, and in Hawaii a serious parasite, especially of young calves (Shishido and Hardy 1969). It is likely to transmit enteric pathogens under unsanitary condition.

Distribution: West Bengal (Alipurduar, Bamankhali, Begnakhali, Bijanbari, Chandanpiri, Ghoramara Island, Jaigaon, Kalyani, Kurseong, Madarihat, Panitanki, Rajabhatkhawa, Ranaghat, Shibpur, Singala Bazar, Siliguri) and almost throughout India.

9. ***Chrysomya indica*** sp. nov. (Figs 1-6)

Male: Body length 7-8 mm.

Head: Eyes bare; upper half of facets not enlarged; frons slightly separated; narrowest part of frons less than the width of ocellar triangle; frontal vitta black; frontal bristles short and weak; parafrontal blackish brown with silvery pollen and numerous fine black hairs; parafacilia blackish brown with silvery pollen and white hairs; gena and metacephalon dark brown with silvery to golden pollen and numerous white hairs; second antennal segment dark brown, third brownish; arista dark brown, long plumose; palpi yellowish and slender.

Thorax: Scutum and scutellum metallic blue with bluish iridescence; four dark not prominent longitudinal stripes on presutural region; *ac* 0+2; *dc* 3+3; *ia* 0+1.; *h* 3: *np* 2; *pa* 2; *ph* 1; st 1+1; *hp*-2; *mp* 6; apicoscutellar bristles 1 pair; discoscutellar bristles 3 pairs; lateroscutellar bristles 3-4 pairs; suprasquamosal ridges hairy; prostigmatic bristles present; mesothoracic spiracles white; metathoracic spiracles dark brown.

Wings: Hyaline and its basal part infuscated; R_1 bare; M_{1+2} sharply bending anteriorly; length of third costal segment more than twice that of the fifth; basicosta and epaulet black; upper squama white; lower squama brownish; halter brown.

Legs: Black to blackish brown; fore femur with a pair of rows of long bristles each along posterodorsal and a row of bristles along posteroventral surfaces; fore tibia with several short bristles along the anterodorsal surface and with short and comparatively long bristles along the distal end and one bristle on distal one-third of the posteroventral surface; mid femur with 2 short bristles on the middle part of anterodorsal surface, a row of setae each on the distal half of anterodorsal and posterodorsal surfaces, 2 bristles on the basal part of anteroventral surface and 3 bristles along the distal part of posterodorsal surface; mid tibia with 1 bristle each on the anterodorsal, anteroventral and posterodorsal surfaces on one-third the distance from the distal end and 2 short bristles on the posteroventral surface; hind femur with a row of long bristles each along anterodorsal and anteroventral surfaces; hind tibia with a row of short bristles along anterodorsal surface and 1 bristle each on distal one-third of anteroventral and posterodorsal surfaces.

Abdomen: Metallic; second abdominal tergite darker than the others and third and fourth tergites with dark transverse bands posteriorly; marginal bristles on abdominal sternites poorly developed; sternites first to fourth dark-brown with greyish pollen and numerous short hairs; fifth sternite cup-like with long hairs on each arm; genital tergites bluish with black hairs; forceps elongated; anterior paramere wide, slightly curved anteriorly; posterior paramere bifurcated at end; acrophallus wide at end and with a wide stalked projection posteriorly.

Female: Unknown.

Specimens examined: **Holotype**: 1♂, India: West Bengal; Sundarbans Biosphere Reserve (Canning), 7.ii.2001, Shuvra Kanti Sinha; **Paratypes**: 6♂♂, same data as Holotype.

Distribution: INDIA; West Bengal (Canning).

Etymology: The species is named after India.

Remarks: This species is similar to *Chrysomya rufifacies* (Macquart 1842), but differs in having 6 mesopleural bristles (*C. rufifacies* has 5 mesopleural bristles) and a wide stalked acrophallus projecting posteriorly (in *C. rufifacies* the acrophallus is unstalked, projecting anteriorly).

Impact on man and animals: Not known.

DISCUSSION

Most calliphorid flies are important because of their relationship with man. There is a direct relationship between fly density and diarrhoeal diseases (Greenberg 1964). Most calliphorid flies breed on excrement and carcasses, and are mechanical transmitters of gastrointestinal diseases when they settle, regurgitate or excrete on food for human consumption. Most people in the Sundarbans Biosphere Reserve use open or unhygienic latrines. These are the main breeding grounds of calliphorid flies, and ideal for pathogens. *Lucilia* (*Lucilia*) *cuprina* and *Lucilia* (*Lucilia*) *sericata* cause widespread loss of livestock and in a bad outbreak 30% of the flock die (Kettle 1995). Baumgartner and Greenberg (1984) mentioned that a few species threatened livestock in the jungle area. Myiasis in goat and cow caused by *Chrysomya rufifacies* has been observed in Ghoramara Island and Sagar Island (Sinha and Nandi 2002). Individuals engaged in dried fish industry suffer most, as the density of flies in dried fish area is high and so is the presence of different types of bacteria, viruses and protozoa. *Calliphora (Calliphora) visina*, *Lucilia* (*Lucilia*) *sericata* and *Chrysomya megacephala* are known to transmit gastrointestinal diseases such as, summer dysentery, bacillary dysentery and amoebic dysentery among individuals in dried-fish farm.

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Abbreviations used in the text

ac-acrostichal bristles, *dc*-dorsocentral bristles, *ia*- intra alar bristles, *h*-humeral bristles, *np*- notopleural bristles, ph-posthumeral bristles, *pa*- post alar bristles, *st*- sternopleural bristles, *hp*-hypopleural bristles, *mp*- mesopleural bristles.

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NEW DESCRIPTIONS

A NEW SPECIES OF THE GENUS *STENOMESIUS* WESTWOOD (HYMENOPTERA: EULOPHIDAE) FROM INDIA[1]

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A new species, *Stenomesius orientalis* (Hymenoptera: Eulophidae), parasitic on *Acrocercops* sp. (Lepidoptera: Gracillariidae), a pest of *Dolichos lablab* L., has been described from India. A key to the Indian species of the genus has also been provided.

Key words: Hymenoptera, Eulophidae, *Stenomesius orientalis* sp. nov., *Acrocercops* sp., *Dolichos lablab* L.

INTRODUCTION

The genus *Stenomesius* Westwood (Hymenoptera: Eulophidae) was based on a single European species *rufescens* (Rossi). Only three species of this genus are known from India. They are all primary ectoparasitoids of lepidopterous larvae, which include leaf miners belonging to families Gracillariidae, Gelechiidae, Lyonettiidae, Glyphiterygidae, Torticidae, Pyralidae and Noctuidae (Boucek 1988).

Genus ***Stenomesius*** Westwood

Stenomesius Westwood. 1833b: 343. Type species *Stenomesius pulchellus* Westwood; designation by Westwood (1939).

A complete synonymy list is given by Boucek (1988: 638).

Diagnosis: The genus can easily be distinguished from allied genera by the following combination of characters: propodeum with a pair of strong median carinae well separated, bowed inwards and joined by a transverse carina (in an H-shape or X-shape); the form of the scutellum, which has a pair of sublateral furrows along the whole length, bent inwards to join before the apical margin; pronotum without transverse carina; female funicle four segmented; temples developed; thorax finely sculptured or partly smooth and shiny; petiole shorter than hind coxa; gaster elongated, first tergite short (Boucek 1988, Figs 1107, 1110).

DISCUSSION

This genus stands close to *Miotropis* Thomson 1878, but *Miotropis* has on the propodeum a pair of median carinae running very close together and converging, and on the scutellum a pair of weak furrows which are only developed anteriorly. These characters are illustrated by Askew (1968) and the *Stenomesius* condition by Masi (1917); Subba Rao and Sharma (1966).

Kerrich (1974) further separated these two genera, *Stenomesius* having a strongly raised occipital margin and a single hind tibial spur, contrasting with an emarginated occiput and two hind tibial spurs in *Miotropis*. *Stenomesius* is more closely related to *Elachertus* Spinola than to *Miotropis* (shared characters of *Stenomesius* and *Elachertus*: more than 4 setae on mesoscutum, scutellum with complete lateral lines which curve inwardly in front of the posterior margin) but the form of the propodeum in *Stenomesius* with two strong median carinae connected before the middle in an H-shape or X-shape, separates the two clearly (Boucek 1988).

Recently, Khan (1992), and Khan and Singh (1994) described two *Stenomesius* species, namely *S. modicellus* and *S. anati* from India.

In the present study, a new species is described and a key to the Indian species provided.

Abbreviations: The following abbreviations are used in the text- F.S. I, F.S. II, F.S. III and F.S.IV - funicular segments I-IV; OOL - oculo-ocellar length, the distance between lateral ocellus and eye margin; POL - postero-ocellar length, the distance between the lateral ocelli; MV - marginal vein; PMV - postmarginal vein; SMV - submarginal vein; SV - stigmal vein.

KEY TO THE INDIAN SPECIES OF THE GENUS *STENOMESIUS* WESTWOOD BASED ON THE FEMALE

1. Antennae light brown except scape light yellow; eyes bare; ocelli arranged in obtuse angled triangle; funicle segments variable in size; speculum greatly reduced; cubital vein sinuate 2

— Antennae black; eyes very finely pubescent; ocelli arranged in equilateral triangle; funicle segments subequal in length; speculum moderate; cubital vein straight .... *S. japonicus* (Ashmead)

2. Head smooth, without fine reticulate sculpture; row of setae adjacent to ocular suture; SMV without a row of setae directed downwards; basal vein with a row of four setae; hindwing with blunt apex, outer plate of ovipositor with a dorsal ridge 3

— Head with fine microreticulate sculpture; no such row of setae adjacent to ocular suture; SMV with a row of five setae directed downwards near the base; basal vein with a row of five setae; hindwing with acute apex; outer plate of ovipositor without dorsal ridge .... *S. modicellus* Khan

3. Head with dark infuscation on middle of the face above antennal sockets, anterior half of scutum, scutellum and axillae with dark brown infuscation; pronotum with a dark patch in the middle; antennae inserted in the middle of the face; prominence between antennal sockets more than one fourth the width of frons between eyes; apex of the scape reaching well above the anterior ocellus; scape slightly curved, more than 6 times as long as wide; pedicel twice as long as wide; F.S. IV as long as F.S. II and twice as long as wide; club thrice as long as wide; mesoscutum strongly reticulate especially in the midlobe; scutellum with 3 pairs of bristles and well developed zigzag grooves from the anterior to posterior margin; mesal length of propodeum almost equivalent to length of mesoscutum; forewing 3 times as long as wide .... *S. anati* Khan and Singh

— Head, thorax and pronotum without any infuscation; antennae inserted just below the middle of the face; prominence between antennal sockets less than one fifth the width of frons between eyes; apex of the scape not reaching above the anterior ocellus; scape cylindrical, more than 5 times as long as wide; pedicel more than twice as long as wide; F.S. IV shortest and more than 1.5 times as long as wide; club a trifle more than thrice as long as wide; mesoscutum without reticulate sculpture; scutellum with 2 pairs of prominent bristles and without well developed zigzag grooves; mesal length of propodeum distinctly slightly longer than the length of mesoscutum; forewing more than 2.5 times as long as wide. .... *S. orientalis* Agnihotri and Khan sp. nov.

Stenomesius orientalis Agnihotri and Khan sp. nov.

(Figs 1-13)

Female: Body length 1.93 mm; general body colour yellow, except gaster which has dorsal tergite slightly infuscated on both sides and with a brown spot just below centre of the gaster; eyes and ocelli red; antennae light brown, except scape which is yellow with infuscation at the apical end; wings hyaline; legs yellow; third valvulae black.

Head (Fig. 1) much wider than long (0.51: 0.36) in facial view; frontovertex much wider than long, width of frontovertex one half the total head width; ocelli arranged in obtuse angled triangle; POL longer than OOL (0.01: 0.09); eyes bare, smooth; antennae inserted just below middle of face; apex of scape not reaching above anterior ocellus, prominence between antennal sockets less than one fifth the width of frons between eyes (0.06: 0.29); length of malar space more than half of eye width (0.07:0.12); mandibles hexadentate (Fig. 2) with two teeth prominent and four short and saw-like; maxillary palps (Fig. 3) and labial palps (Fig. 4) 2- and 1-segmented, respectively.

Antenna (Fig. 5) densely setose, 8 segmented excluding 2 ring segments; scape more than 5 times as long as wide (0.27:0.05); pedicel more than twice as long as wide (0.10:0.04); funicle 4 segmented, F.S. I and F.S. II equal in size and more than twice as long as wide (12:0.05), F.S. III longest, 2.8 times as long as wide (0.14:0.05), F.S. IV shortest, 1.83 times as long as wide (0.11:0.06); club short, 2-segmented, more than 3 times as long as wide (0.17:0.05) with a spicule.

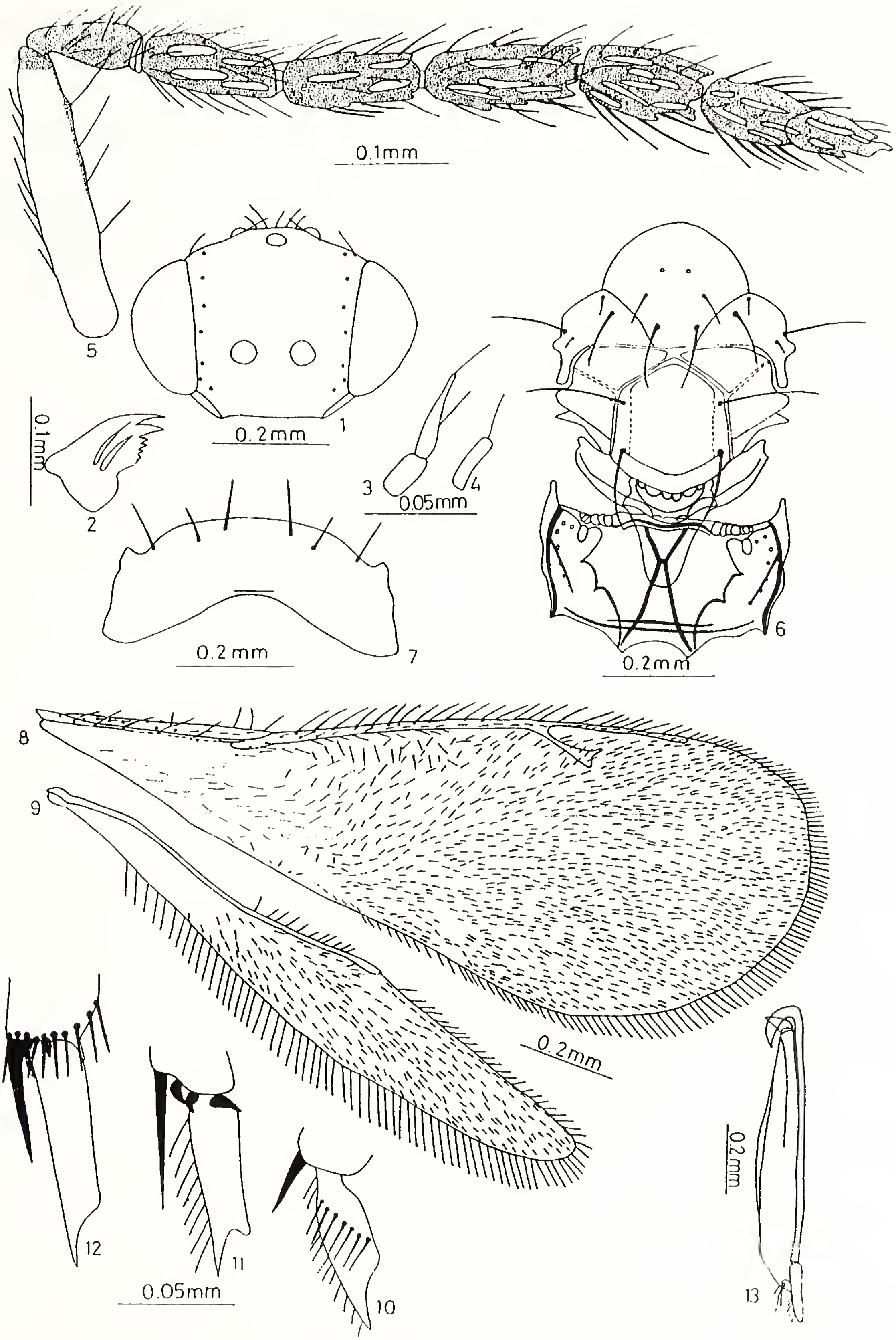
Thorax (Fig. 6) posterior margin of pronotum with 3 pairs of setae (Fig. 7); mesoscutum width less than twice its length (0.44:0.26) with well developed parapsidal furrows, side lobe with shoulder-like projection as shown in Fig. 6, 8 short and 4 long setae on the mesoscutum; scutellum longer than wide (0.28: 0.25) with 2 pairs of long setae; axillae narrowly contiguous in the middle; propodeum highly carinated as shown in Fig 6; mesal length of propodeum slightly longer than the length of mesoscutum.

Forewing (Fig. 8) densely setose, more than 2.5 times as long as wide (1.64: 0.64); costal cell moderate with 4 setae on upper margin and with a row of 14 setae on its underside; basal vein with a row of 4 setae; basal cell setose; speculum much reduced and closed below; cubital vein slightly sinuate; subcubital line of hairs moderately long near the base; an irregular row of hairs present between cubital vein and subcubital vein; SMV (0.49) with 6 long setae directed upwards and shorter than MV (0.57); PMV very long, more than twice as long as SV (0.29:0.13); marginal fringes separated by a distance equal to one fourth of their length.

Hindwing (Fig. 9) hyaline, with blunt apex, slightly more than 6.5 times as long as wide (1.33: 0.20), marginal fringes separated by a distance almost equal to one fifth of their length.

Legs fore-basitarsus with an oblique row of 7 setae (Fig. 10); apical rim of midtibia with 3 pegs and long spur (Fig. 11); apical rim of hind tibia with 2 pegs and 10 setae (Fig. 12).

Gaster longer than head and thorax together; petiole short; ovipositor slightly exserted, arising from near the base;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12
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Figs 1-13: *Stenomesius orientalis* sp. nov.
1. Head frontal aspect; 2. Mandible; 3. Maxillary palp; 4. Labial palp; 5. Antenna; 6. Thorax, dorsal view; 7. Pronotum; 8. Fore wing; 9. Hing wing; 10. Part of fore leg; 11. Part of middle leg; 12. Part of hind leg; 13. Female genitalia

first valvifer triangular with slight concave base (Fig. 13); third valvulae slightly less than 6 times as long as wide (0.17: 0.03) and more than one-fourth the length of second valvifer (0.74); outer plates of ovipositor as long as second valvifer.

Male: Not known

Holotype: ♀ INDIA, U.P. Haldwani, ex. *Acrocercops* sp. (Lepidoptera: Gracillariidae) ex. *Dolichos lablab* 23.v.2000. Hym. Eulo. Nr. 1006, Coll. Meena Agnihotri.

Paratypes: 3 ♀ ♀. Same data as Holotype. Hym. Eulo. Nr. 1006, Coll. Meena Agnihotri.

Holotype and Paratypes have been deposited in the Entomological Museum, G.B.P.U.A & T, Pantnagar, India.

Etymology: The species is named from its distribution in the Oriental region.

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HITHERTO UNKNOWN GENERA OF SPIDERS, *ORDGARIUS* KEYSERLING, *PASILOBUS* SIMON (ARANEIDAE) AND *STRIGOPLUS* SIMON (THOMISIDAE) FROM EASTERN INDIA[1]

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The paper deals with the taxonomy of 3 hitherto unknown genera, *Ordgarius* Keyserling, *Pasilobus* Simon (Araneidae) and *Strigoplus* Simon (Thomisidae) from eastern India. The species *O. hexaspinus* and *S. bilobus* are recognized as new to science, and hence described and illustrated. The genus *Pasilobus* still appears to be monotypic as till date it is known only by *P. kotigeharus* Tikader. All the species are recorded from Buxa Tiger Reserve, Jalpaiguri, West Bengal.

Key words: Spiders, unknown genera, *Ordgarius hexaspinus* n. sp., *Strigoplus bilobus* n. sp., *Pasilobus kotigeharus* Tikader, eastern India, West Bengal, Jalpaiguri, Buxa Tiger Reserve

INTRODUCTION

The present paper reports the hitherto unknown araneid genera, *Ordgarius* Keyserling and *Pasilobus* Simon and a thomisid genus *Strigoplus* Simon from eastern India. The genus *Ordgarius* is known from India by two species only, both of which have so far been recorded from localities in Maharashtra (Tikader 1982). The genus *Pasilobus* is monotypic and known only from the state of Karnataka in India. Both *Ordgarius* and *Pasilobus* have large distributional areas; up to Australia and Japan (Tikader 1982).

Strigoplus so far a monotypic genus, is known in India only from Karnataka. Its distribution ranges from Malaysia, Myanmar to Indonesia (Tikader 1980).

O. hexaspinus and *S. bilobus* are recognized as new and hence described and illustrated. All the 3 species, *O. hexaspinus* n. sp., *P. kotigeharus* Tikader and *S. bilobus* n. sp. are recorded from the Buxa Tiger Reserve, Jalpaiguri, West Bengal.

MATERIAL AND METHODS

Collection and preservation of the spider samples were done following Tikader (1987). The materials were studied using a stereozoom binocular microscope, model Zeiss, SV8. All the measurements were made with an eyepiece graticule and are in millimetres.

Family: Araneidae

Ordgarius hexaspinus n. sp. (Figs 1-6)

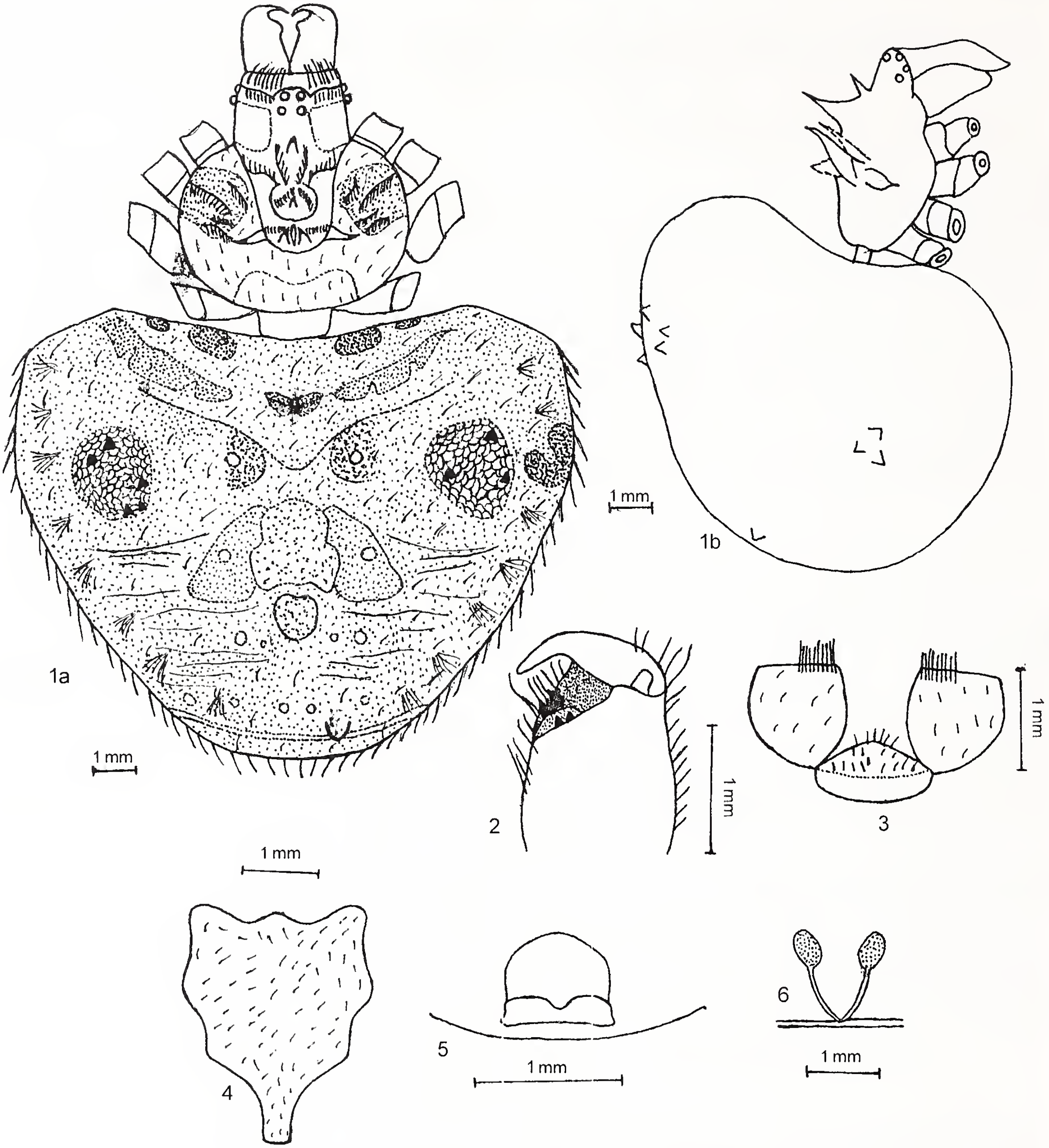
Holotype: Female: Total length 16.28; carapace length 5.64, width 5.43; abdominal length 9.93, width 13.14; legs as in Table 1.

Carapace: Cephalothorax brown, anterior half darker, basally paler; almost as long as wide, narrowing in front, cephalic region squarish, strongly raised; medially armed with an acute horn on a raised tubercle encircled by a brown band, anterior to it a smaller acute horn directed upward-forward, posterior to it two pairs of dark acute horns on a raised area, of these median ones closer, thicker, directed upward-forward, enclosing the dark thoracic longitudinal fovea, lateral ones longer, horizontal. Eyes pale yellow, placed on raised tubercles, both rows recurved, ocular quad wider than long, slightly wider in front than behind, median eyes subequal, lateral eyes close, anterolaterals slightly larger. Clypeus pale yellow, produced. Chelicerae pale yellow, with long hairs, robust, each of inner and outer margins with a pair of teeth, fang brown, strongly curved. Maxillae and labium pale yellow, maxillae broader, robust, apically truncate, inner apical angle scopulate; labium short, transverse, band-like, basally constricted, anteriorly paler, produced, with long hairs. Sternum pale yellow, elongate, posteriorly produced, with long hairs and few spines. Legs pale yellow with brown annulations, clothed with long hairs; leg formula 1243.

Abdomen: Pale brown with whitish patches, broadly 'U' shaped, anteriorly concave, posteriorly round; hairs long

Table 1: Measurements of legs of ♀ Holotype of *Ordgarius hexaspinus* n. sp. (in mm)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	5.4/5.6	6.8/6.8	4.6/4.8	1.2/1.2	18.0/18.4
II	4.8/4.6	6.4/6.2	3.0/3.0	1.2/1.2	15.4/15.0
III	3.2/3.2	4.4/4.4	3.2/3.0	0.8/0.8	11.6/11.4
IV	4.0/4.2	5.8/5.6	2.4/2.6	0.8/0.8	13.0/13.2



Figs 1-6: *Ordgarius hexaspinus* n. sp.; female holotype
1. Whole body, a) dorsal view, b) lateral view; 2. Chelicerae,
3. Maxillae and labium, 4. Sternum, 5. Epigynum, 6. Internal genitalia

and fine, with bases rather dark; often with marginal tufts of hairs; wider than long, narrowing behind, clothed with fine hairs, anterior half basally with two circular areas submedially, marked by honey comb pattern and few short blunt tubercles, another such tubercle at the posterior end almost medially, below which transversely depressed, marked by a broad brown band, sigilla in 4 transverse rows. Venter paler, with white honeycomb pattern and numerous brown spots. Epigyne and internal genitalia as in Figs 5 and 6.

Male: Unknown.

Specimens examined: **Holotype**, Female, Rajabhatkhawa, Buxa Tiger Reserve, Jalpaiguri, West Bengal,

Table 2: Differences in characters between *Ordgarius hexaspinus* sp. nov. and *O. sexspinosus*

	O. hexaspinus n. sp.		*O. sexspinosus* (Thorell)
1.	Carapace with 6 horns; median one small; anterior most large, single	1.	Carapace with 7 horns tubercles; median large; anterior most small, paired
2.	Abdomen broadly U-shaped, never overlapping carapace, with anterior margin concave	2.	Abdomen V-shaped, overlapping carapace, with anterior margin nearly straight
3.	Basal 1/3 of abdominal dorsum with submedian tubercles restricted on a reticulate area	3.	Abdominal dorsum with laterally distributed tubercles
4.	Abdominal tip round with single tubercle	4.	Abdominal tip 'W' shaped with 2 pairs of tubercles
5.	Abdominal hair tufts not on tubercles	5.	Abdominal hair tufts on tubercles
6.	Epigyne and internal genitalia very different	6.	—

India, 8.iii.2001, Coll. D. Raychaudhuri [Deposited in the Entomology Laboratory, Department of Zoology, University of Calcutta]. Regn. No. EZC 0001-01.

Paratypes: Nil.

Distribution: INDIA: West Bengal, Jalpaiguri (only known from type locality).

Discussion: The present species *Ordgarius hexaspinus* n. sp. resembles *O. sexspinosus* (Thorell), but yet stands distinct (Table 2).

Etymology: The specific name is derived from the six horns on the carapace.

Pasilobus kotigeharus Tikader

1963 *Pasilobus kotigeharus* Tikader, *Proc. Indian Acad. Sci. 57(2)*: 96.

1982 *Pasilobus kotigeharus* Tikader, *Fauna of India, Spiders.* Vol. II, Pt. 1, Araneae: Araneidae Zool. Surv. India, Calcutta: 156-157.

Specimen examined: 1 Female, Rajabhatkhawa, Buxa Tiger Reserve, Jalpaiguri, West Bengal, 8.iii.2001. Coll. S. Saha (Deposited in the Entomology Laboratory, Department of Zoology, University of Calcutta). Regn No. EZC 0002-01.

Family: Thomisidae

Strigoplus bilobus n. sp. (Figs 7-12)

Holotype: Female: Total length 7.50; carapace length 3.08, width 2.54; abdominal length 4.08, width 3.54; legs as in Table 3.

Carapace: Cephalothorax dark blackish brown with a pale yellow brown area extending from the middle of the carapace, continuing up to the anterior margin of clypeus, almost round, longer than wide, with scarce long acute brown-black hairs, their bases raised, placed marginally, less so medially; rest with short pale brown hairs, with bases rather dark. Eyes brown black with pale basal bands, in two rows, both recurved, lateral eyes on tuberculate bases, anterolaterals largest, posteromedians smallest, ocular quad transversely rectangular, medially provided with small spatulate black hairs in transverse rows. Clypeus broad, transverse, anterolateral angles bilobed, each with a long acute black hair, anterior margin broadly and deeply concave, with small black spatulate hairs, those in the middle smaller and in rows. Chelicerae pale brown, from the top broad, robust, basally with black spatulate hairs as on the clypeal margin, with a few long acute ones, further forward with fine long hairs, from below darker, devoid of any hair, scopulate near fang base, margins without teeth, fangs golden brown, curved. Maxillae and labium greyish, both anteriorly produced and narrowing, sole-like, surface with short black spatulate hairs, maxillae marginally with few fine hairs, both apically scopulate. Sternum black, heart-shaped, with long hairs as on dorsum. Legs III and IV yellow, black annulations near the apical joints, these whitish on IV; I and II darker with irregular markings/patches, often annular, ventrally black; leg formula 1234.

Abdomen: Dark blackish brown with a few white bands and spots as in Fig. 7, pentagonal, with long brown hairs. Venter dark brown with whitish spots. Epigyne and internal genitalia as in Figs 11 and 12.

Male: Unknown.

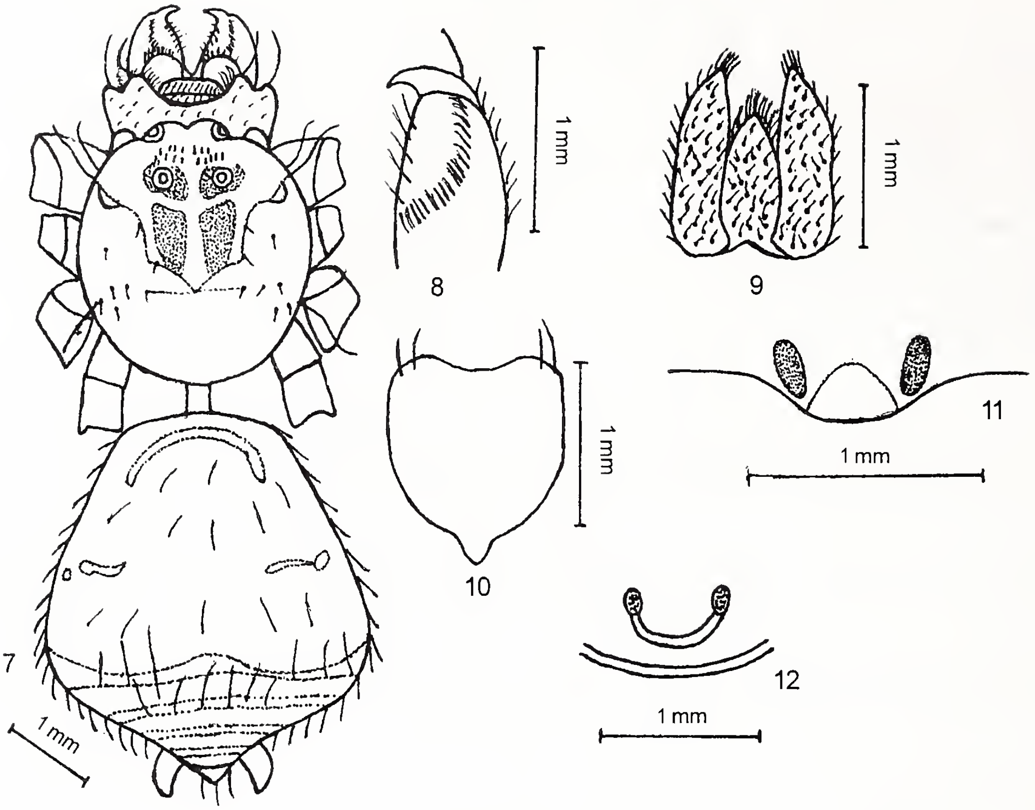
Specimens examined: Holotype, Female, Rajabhatkhawa, Buxa Tiger Reserve, Jalpaiguri, West Bengal, India, 8.iii.2001, Coll. S. Saha (Deposited in the Entomology Laboratory, Department of Zoology, University of Calcutta). Regn. No. EZC 0003-01.

Paratypes: Nil.

Distribution: INDIA: West Bengal, Jalpaiguri (only known from type locality).

Table 3: Measurements of legs of ♀ holotype of *Strigoplus bilobus* n. sp. (in mm)

Leg	Femur	Patella & Tibia	Metatarsus	Tarsus	Total
I	2.6/2.8	3.2/3.2	2.0/2.0	1.6/1.8	9.4/9.8
II	2.6/2.6	3.2/3.4	1.6/1.6	1.6/1.4	9.0/9.0
III	1.4/1.6	2.6/2.6	0.8/0.8	1.2/1.2	6.0/6.2
IV	1.2/1.2	2.0/1.8	0.6/0.6	1.2/1.0	5.0/4.6



Figs 7-12: *Strigoplus bilobus* n. sp., female holotype
7. Whole body, 8. Chelicerae, 9. Maxillae and labium, 10. Sternum, 11. Epigynum, 12. Internal genitalia

Table 4: Differences in characters between *Strigoplus bilobus* sp. nov. and *S. netravati*

	Strigoplus bilobus n. sp.		*Strigoplus netravati* Tikader
1.	Clypeus with anterior lateral angles bilobed, each with a long hair at tip, inner margin of inner lobe with long spatulate hairs	1.	Clypeus with anterior lateral angles not bilobed and devoid of long hairs
2.	Ornamentation of carapace and abdomen much different	2.	—
3.	Leg I longer than II	3.	Leg II longer than I
4.	Epigyne and internal genitalia much different	4.	—

Discussion: Differences between the proposed new species *Strigoplus bilobus* and *S. netravati* Tikader are given in Table 4.

Etymology: The specific name is derived from the bilobed anterior angles of the clypeus.

ACKNOWLEDGEMENTS

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A NEW SPECIES OF *RASBORA* BLEEKER (CYPRINIFORMES: CYPRINIDAE) FROM MANIPUR, INDIA[1]

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A new fish species of the genus *Rasbora* Bleeker is described from the Lokchao and Chatrickong rivers (Chindwin drainage) of Manipur, India. It is distinguished from *Rasbora rasbora* (Hamilton-Buchanan), the only other known species from the region, by the lateral line incomplete vs. complete, lateral transverse scale 4½/1/2 vs. 4½/1/1, greater head length of 29.3(27.5-31.1) vs. 24.5(22.1-26.9)% of SL, greater gape width of 8.1(7.1-9.1) vs. 6.8(6.0-7.6)% of SL and gill rakers numbering 4-5+11 vs. 3+9-10.

Key words: New fish species, *Rasbora*, Manipur

INTRODUCTION

Freshwater fishes of the genus *Rasbora* Bleeker belong to subfamily Danioninae (=Rasborinae). Certain rasboras are much prized aquarium fishes (Brittan 1954). Four species of the genus are known from India, namely *R. caverii* (Jerdon), *R. daniconius* (Hamilton-Buchanan), *R. labiosa* Mukerji and *R. rasbora* (Hamilton-Buchanan). Hora (1921) reported *R. rasbora* (Hamilton-Buchanan) from Dhaneshwori stream near Dimapur, Nagaland, which forms part of the Brahmaputra drainage system. Further, Hora and Mukerji (1935) reported the species to be widely distributed. Vishwanath *et al.* (1998) listed *R. rasbora* from Chatrickong river, Ukhrul district, Manipur. A fish collection from the Lokchao river (a tributary of the Yu River of Myanmar which, in turn, flows into the Chindwin river) in Chandel district of Manipur and from Chatrickong river (a tributary of Chindwin river) in Ukhrul district, included 14 specimens of *Rasbora* which did not fit into any of the hitherto described species. The species is described here as a new species.

MATERIAL AND METHODS

Measurements and counts followed Brittan (1954). Measurements were made with dial callipers to the nearest 0.1 mm and expressed in percentages of standard length (SL) and head length (HL). Type specimens are deposited in the Manipur University Museum of Fishes (MUMF).

Rasbora ornatus sp. nov. (Fig. 1)

Holotype: MUMF 3032, 56.0 mm SL, Lokchao R., Moreh, Manipur, a tributary of the Yu River, (Chindwin drainage), 24.iii.1999, W. Vishwanath Singh and party.

Paratypes: MUMF: 1210-1212, 3 specimens, 44.2-57.1 mm SL, Chatrickong R., 6.vi.1996, K. Selim; MUMF 3033/10, 10 specimens, 35.1-77.6 mm SL, same data as holotype.

Diagnosis: A medium-sized *Rasbora* with an incomplete lateral line. Lateral transverse scales 4½/1/2. Lips simple, first dorsal fin ray without a fleshy sheath and the lateral stripe on body running from tip of snout to the end of median caudal rays.

DESCRIPTION

D. ii, 7; P. i, 12-13; V. i,8; A. iii,5; C. 9+8. Body elongate, slightly compressed, its depth 28.0 (21.1-29.3)% SL. Mouth small, cleft oblique, lip simple, lower jaw slightly prominent with an upward projecting knob at symphysis fitting into a corresponding depression in upper jaw. Barbels absent, pharyngeal teeth in three rows 2,4,5-5,4,2. Gill rakers soft and low, 4-5+11. Branchiostegal rays 3. Lateral line with a downward curvature anteriorly, runs along below centre of body and terminates at a line vertical to anterior origin, or sometimes at posterior extremity of dorsal fin. Lateral line incomplete, 26-28 scales in longitudinal series with 11-20 scales perforated. Lateral transverse scales from dorsal fin origin to the lateral line 4½ and from lateral line to origin of pelvic 2. Dorsal fin inserted a little behind origin of pelvic fin, nearer to

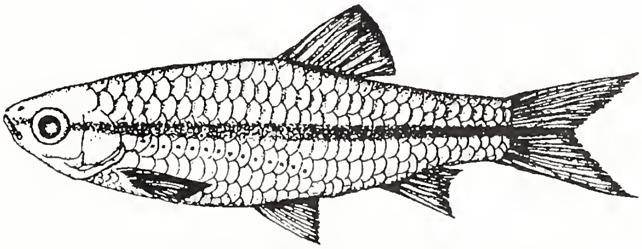

Fig. 1: Lateral view of *Rasbora ornatus* sp. nov.

caudal fin base than to tip of snout. Pelvic fin not reaching base of anal fin. Head moderate, eyes large, visible from ventral side. Inter-orbital space wide, slightly arched, 35.7(29.8-39.0)% HL. Inter-narial space 24.6(20.8-27.6)% HL. Mouth gape wide. Dorsal-hypural distance when carried forward, falling at anterior rim of eye. Sexual dimorphism unknown.

Colour: Body creamish, abdomen pale, dorsal part of head brownish. A deep dark blue longitudinal stripe extending from tip of snout to end of median caudal rays. Scales on lateral and dorsal sides of body with a dark edge formed by a row of spots on each scale. All fins dusky in appearance.

Etymology: The species is named after its beautiful colouration.

Distribution: INDIA: Manipur, Lokchao R., Moreh, Chatrickong R.

Remarks: *Rasbora ornatus* sp. nov. belongs to the Daniconius-complex as it has 14 circumpeduncular scales, 2 scales between lateral line and pelvic fin origin, the typical characters of the complex. As in some forms of this complex, this species shows reduced number of lateral line pores and prominent dark lateral stripe, which runs from the tip of the snout to the median caudal rays.

Rasbora ornatus sp. nov. differs from *R. rasbora* in having an incomplete lateral line vs. complete and lateral transverse scale of 4½/1/2 vs. 4½/1/1. It has longer head length, 29.3(27.5-31.1) vs. 24.5(22.1-26.9)% SL, wider gape

Table 1: Comparative morphometry of *Rasbora ornatus* sp. nov. and *R. rasbora*

	Rasbora ornatus sp. nov.				*Rasbora rasbora (H.B.)*	
	Holotype MUMF 3032	Paratypes (N=13) MUMF 3033/10, 1210/3			ZSI F 2107/2, 1087	
		Range	Mean	S.D.	Range	Mean
Standard length (mm)	56.0	35.1-77.6			65.5-124.1	
% of Standard length						
Body depth	29.3	21.1-29.3	28.0	2.1	26.0-30.5	28.3
Caudal length	27.5	26.3-32.4	30.2	1.7	18.9-28.9	23.9
Head length	27.5	27.5-31.1	29.3	0.9	22.1-26.9	24.5
Head depth (occiput)	17.7	16.8-19.5	18.4	0.6	14.8-17.6	16.2
Head depth (eye)	15.0	13.2-15.2	14.8	0.7	11.6-13.9	12.8
Head width (nares)	10.5	8.9-10.9	10.2	0.6	7.8-8.7	8.3
Max. head width	14.3	13.2-15.7	14.7	0.7	12.5-12.6	12.6
Mouth Gape width	9.1	7.1-9.1	8.1	0.5	6.0-7.6	6.8
Body width (dorsal)	15.5	12.4-15.5	14.7	1.0	10.1-12.7	11.4
Body width (anal)	10.4	7.4-10.7	10.0	1.1	8.6-8.6	8.6
Length of caudal peduncle	17.5	13.8-18.2	15.9	1.5	17.6-20.2	18.9
Height of caudal peduncle	13.0	11.9-14.8	13.8	0.5	13.3-13.4	13.4
Pre-dorsal length	52.5	52.1-55.6	53.3	1.0	52.7-53.9	53.1
Post-dorsal length	49.1	44.2-49.1	46.8	1.5	45.7-46.6	46.2
Pre-pelvic length	51.9	47.6-52.6	51.2	1.1	48.6-49.0	48.8
Pre-anal length	74.6	70.2-75.7	73.8	1.7	67.5-73.6	70.6
Pre-anus length	73.0	69.1-74.1	72.0	1.6	66.1-71.6	68.9
Dorsal fin base length	11.4	10.6-13.1	12.4	0.8	10.4-11.5	11.0
Dorsal fin height	20.5	20.2-25.4	22.3	1.5	17.1-22.4	19.8
Pectoral fin length	18.8	18.8-22.8	21.4	1.2	21.0-21.7	21.4
Pelvic fin length	16.6	16.6-19.8	18.5	0.8	14.6-19.5	17.1
Anal fin base length	7.0	7.0-12.1	9.7	1.3	9.6-10.2	9.9
Anal fin height	17.0	16.0-20.2	18.7	1.3	8.9-17.1	13.0
% of Head Length						
Snout length	29.9	23.2-29.9	26.4	1.8	26.7-27.0	26.9
Eye diameter	24.0	22.9-31.3	25.9	2.3	27.8-30.7	29.3
Inter-orbital width	37.0	29.8-39.0	35.7	2.5	25.6-37.5	31.6
Inter-narial width	25.3	20.8-27.6	24.6	1.8	13.9-21.0	17.5
Other ratios						
ED*/Snout length	80.4	80.4-134.8	94.9	15.1	104.3-113.5	108.9
ED/IOW*	64.9	60.9-93.9	73.1	10.3	74.2-120.0	97.1
LCP/HCP*	1.3	0.9-1.5	1.2	0.1	1.5-1.9	1.7

* ED: Eye diameter; IOW: Inter-orbital width, LCP: Length of caudal peduncle; HCP: Height of caudal peduncle

Table 2: Morphometry and distribution of *Rasbora* species closely allied to *R. ornatus* sp. nov.

Sl. No.	Characters	*Rasbora ornatus* sp. nov	*Rasbora rasbora* (Ham.-Buch.)		*Rasbora daniconius* (Ham.-Buch.)	*Rasbora labiosa* (Mukerji)
			F2107/2, 1087	Brittan (1954)		
1	Lateral line pores	11-20	28-31	28-31	29-32	23-31
2	Lateral line scales	26-28	28-31	28-31	32-35	33-35
3	Lateral transverse scales	4½/1/2	4½/1/1	4½/1/1½	4½/1/2½	4½/1/2½
4	Dark coloured lateral longitudinal band	Snout tip to end of median caudal rays (tip of caudal black)	Opercle to caudal fin base	Opercle to caudal fin base	Snout tip to caudal base	Opercle to caudal fin base
5	Circumpeduncular scales	14	13	12	14	14
6	Pre-dorsal scales	12-13	13	12	13-15	14-15
7	Pre-pelvic scales	13	15	-	-	-
8	Pre-anal scales	20	24	-	-	-
9	Gill rakers	4-5+11	3+9-10	-	2-3+9-12	-
10	Distribution	India: Chindwin drainage in Manipur	India: Gangetic provinces, Coromandel coast. Bangladesh, Myanmar, Thailand	India: Gangetic valley, Assam, Peninsular region. Myanmar, Siam	Widely distributed in Indian region	India: Deolali, Maharashtra state

width of 8.1(7.1-9.1) vs. 6.8(6.0-7.6)% SL. Gill rakers 4-5+11 vs. 3+9-10 (Roberts 1989). Circumpeduncular scale rows 14 vs. 12-13. The lateral stripe in *R. ornatus* sp. nov. runs from tip of snout to median caudal rays, whereas it extends from opercle to base of caudal fin in *R. rasbora*. Three specimens of *Rasbora* (MUMF 1210-1212) from Chatrickong R., Ukhrul district, Manipur, identified as *R. rasbora* by Vishwanath *et al.* (1998) have been found to have incomplete lateral lines and therefore belong to the new species.

R. ornatus is distinguished from the description given by Brittan (1954) of *R. labiosa* Mukerji of the Daniconius complex in having 11-20 vs. 23-31 lateral line pores, 26-28 vs. 33-35 in the lateral line series, lateral transverse scales 4½/1/2 vs. 4½/1/2½; simple lips vs. greatly hypertrophied lower lip, and fleshy sheath on the first dorsal fin ray absent vs. present. Jayaram (1999) considers the latter two characters as important distinguishing features of *R. labiosa* Mukerji from other species.

It does not belong to the Pauciperforata complex, which show incomplete lateral line because of its larger size, 35.1-77.6 vs. less than 55 mm SL, 14 vs. 12 circumpeduncular scale rows.

The specimen of *Rasbora rasbora* (F 2516/2) in Zoological Survey of India, Kolkata, on close examination has 14 anal fin rays, much more than the usual numbers in other species of the genus (5-6). Its dorsal fin is inserted much backward, i.e., nearer the caudal fin base (predorsal length is 66.4% SL and post-dorsal length is 32.7% SL). Brittan (1954) places fishes with such characters in other genera of Danioninae.

Comparative materials.

1. *Rasbora rasbora* (Hamilton-Buchanan), F. 2107/2 ZSI, Dharikati, 3½ miles R. Bharati near Lokra (Balipara F. track, Assam). Dr. S.L. Hora, no date.
2. *R. rasbora*, 1087 ZSI, no collection data.

ACKNOWLEDGEMENT

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A NEW FISH OF THE GENUS *ACANTOPSIS* VAN HASSELT (CYPRINIFORMES: COBITIDAE) FROM MANIPUR, INDIA[1]

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A new fish species, *Acantopsis multistigmatus* is described from the Lokchao river, a tributary of the Yu river in Manipur. It is distinct from *A. thiemmedhi* Sontirat by its greater number of vertebrae (43 vs. 39-41); greater number of dark brown blotches on the sides (14-17 vs. 8-9); regular, round and smaller blotches vs. irregular and larger blotches on sides; greater number of saddles (17 vs. 8-9); dorsal fin with 3 dark bands vs. 1 band near the rim and another dark spot on the middle of 1-3 dorsal rays; caudal fin with three transverse bands vs. 1 large oblong dark bar on each caudal lobe; pectoral, pelvic and anal fins with dark spots vs. only dorsal and caudal fins banded. It is distinct from *A. choirorhynchos* (Bleeker) by its smaller number of gill-rakers (18 vs. 21-27); characteristic colour pattern of dorsal and caudal fins mentioned above vs. absent on dorsal and caudal fins (except occasionally in smaller specimens); smaller head length 22.1 (21.3-22.5) vs. 25.6 (24.4-27.4) and smaller pre-pectoral length (18.8-20.2) vs. 23.5 (21.9-25.2) all in % of SL.

Key words: New fish species, *Acantopsis*, Manipur

INTRODUCTION

The hill-stream loaches of the genus *Acantopsis* van Hasselt are highly elongate, cylindrical and colourful fish that are found underneath sand and in between gravel and coarse sand (Sontirat 1999). *Acantopsis choirorhynchos* (Bleeker) was described by Bleeker (1854) as *Cobitis choirorhynchos* from Sumatra. Chen (1981) placed *Acantopsis lachnostoma* Rutter, as a junior synonym of *A. choirorhynchos,* extending its range as far as southern China. However, Roberts (1989) recognized the validity of *A. lachnostoma* and its endemic distribution in southern China, based on its differences with *A. choirorhynchos,* on comparing the holotype of *A. lachnostoma* with two typical specimens of *choirorhynchos* from Kapuas, Western Borneo. He also remarked on the poorly known systematics of the genus, which made it difficult for him to comment on its distribution. While describing *A. thiemmedhi* from Thailand, Sontirat (1999) mentioned that the genus *Acantopsis* was till then known from Thailand as *A. choirorhynchos* alone. Thus, the geographical distribution of the species is concentrated around the far-east Asian region. It is in no way connected with the Chindwin River system. Talwar and Jhingran (1991) reported the occurrence of the species from Assam, India and Myanmar, while Menon (1992) stated that it was distributed in the Indo-Australian Archipelago and South-eastern Asia. He made a description of the species based on six specimens from Irrawady river at Mandalay and Chindwin drainage at Kunghein, collected during the Vernay-Hopewood Upper Chindwin Expedition in 1935. Rainboth (1996) noted that *A. choirorhynchos* and *A. dialuzona* from Cambodian Mekong are misidentifications. Jayaram (1999), while reporting distribution of the genus in Southeast Asia noted that the only species from the Indian region was *A. choirorhynchos* from Assam. In view of very little data available on the genus and contradictory statements of workers, a detailed study on the taxonomy and distribution of *Acantopsis* is essential.

This paper describes a new species of the genus *Acantopsis* van Hasselt from the Lokchao river, Manipur, a tributary of the Yu river.

MATERIAL AND METHODS

Fish were collected from Moreh market and immediately preserved in 10% formaline solution. Measurements and counts followed Jayaram (1999) and are expressed as percentages of standard length (SL) and head length (HL). Measurements were made with dial callipers (Mitutoyo, Japan) to the nearest 0.1 mm. The type specimens are deposited in the Manipur University Museum of Fishes (MUMF). Counting of vertebrae was done by Alizarin Red S staining technique for bones as described by Hollister (1934).

Holotype: MUMF 3044, 205.4 mm SL, Lokchao river, Manipur. 24.iii.1999, W. Vishwanath Singh and party.

Paratypes: MUMF 3045/5, 152.9-203.6 mm SL, same data as holotype. MUMF 3047/1, 121.8 mm SL, Lokchao river, Manipur. 18.v.2001. Juliana Laisram. MUMF 3048/1, 142.3 mm SL, Lokchao river, Manipur. 23.v.2000. JL.

Local name: Ching ngakrijrou (Manipuri)

Diagnosis: A hill-stream loach with a very elongate and cylindrical body, 14-17 lateral blotches arranged longitudinally

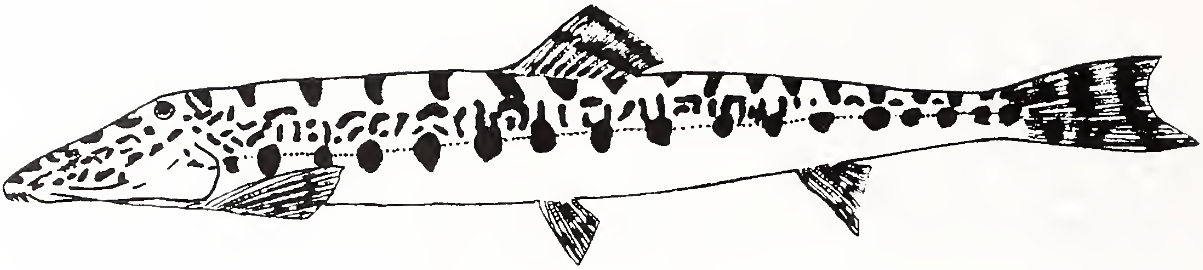

Fig. 1: Lateral view of *Acantopsis multistigmatus* sp. nov.

on the flanks and 17 dark brown saddles across the back, a pattern of many small, transverse and horizontal wavy bars and spots arranged longitudinally between the saddles and the blotches. Three rows of dark brown spots on dorsal fin and two on pelvic fin. No black spot at the upper base of caudal fin. Pectoral, pelvic and anal fins spotted with black. Caudal fin slightly emarginated. Gill-rakers 18 (4+14).

Description: D. iii, 9½; P. i, 9-10; V. i, 6; A. iii, 5; C. 7+7.

Body very elongate and compressed, its depth 10.9 (9.7-12.0), head long, 21.9 (21.3-22.4), longer than caudal length which is 15.9 (13.8-17.4) all in % SL. Snout much elongated, 68.3 (65.4-70.6)% HL and pointed. Eyes small, subcutaneous, situated dorsally very close to the occiput, its diameter longer than inter-orbital width. An erectile bifid spine present between the nostrils and orbit, nearer to the nostrils, level with the lower margin of the orbit. Mouth small, inferior. Barbels four pairs, two rostral and two maxillary, all small. Lips thick, both fringed, mental lobes well developed into two fringed prolongations. Gill openings small, extending only a little above origin of pectorals.

Caudal peduncle long, its least depth 2.6 (2.4-2.8) in its length. Scales minute, absent on head. Lateral line complete. Dorsal fin origin midway between tip of snout and caudal fin base, slightly in advance of ventral fin origin. Anal fin short, caudal fin slightly emarginate, the lower lobe longer. Ventral fin nearer caudal fin base than tip of snout (Fig. 1).

Colour: Creamy yellow with 14-17 lateral blotches arranged longitudinally on flanks and 17 saddles across back; pattern of many small, transverse and horizontal wavy bars and spots arranged longitudinally between the saddles and the blotches, all in dark brown tints. Three rows of dark brown spots on dorsal fin, two on pelvic fin. Pectoral, pelvic and anal fins spotted with black. The pattern on the body is also found on the head.

Distribution: INDIA: Lokchao river, Manipur, Assam. Myanmar.

Etymology: The species is named after the large number of deep dark brown blotches on the sides.

Remarks: *Acantopsis multistigmatus* sp. nov. is distinguished from *A. choirorhynchos* in having fewer gill-

Table 1: Morphometry and distribution of *A. multistigmatus* sp. nov., *A. thiemmedhi* and *A. choirorhynchos*

Characters	*Acantopsis multistigmatus* sp. nov	*A. thiemmedhi* Sontirat	*A. choirorhynchos* Sontirat 1999
Gill-rakers	18	16-18	21-27
Colour	14-17 blotches, 17 saddles on dorsal part of body. 3 rows of black spots on dorsal and 2 rows on caudal fins. Pectoral, pelvic and anal fins spotted with rows of dark spots.	8-9 irregular blotches, 8-9 saddles on dorsal part of body. 1 row and a blotch at 1st three dorsal rays. 1 large oblong dark bar near the middle part of each caudal lobe. Only dorsal and caudal fins banded, other fins hyaline.	No markings on caudal and dorsal fins. However, small dark lateral spots and blotches on sides and back and three rows of small dark spots on dorsal may or may not be present in small specimens.
Vertebrae	43	39-41	40-44
Caudal fin	Slightly emarginate	Bilobed	—
Max. SL	181 mm	132 mm	—
Distribution	Lokchao river, Manipur, India	Thailand	India: Assam, Borneo, Java, Malaya, Myanmar, Sumatra, Thailand, Vietnam. (Jayaram 1999)

Table 2: Morphometric comparison of *A. multistigmatus* sp. nov. with *A. thiemmedhi* and *A. choirorhynchos*

	A. multistigmatus sp. nov.		*A. thiemmedhi* Sontirat (1999) Mean (Range)	*A. choirorhynchus* Sontirat (1999) Mean (Range)
	Holotype MUMF 3044	Paratype (N=7) MUMF 3045/5, 3047/1, 3048/1 Mean (Range)		
Standard Length	181.0	103.2-181.0	-	-
Body Depth	9.9	10.6(9.7-12.0)	13.5(12.3-15.2)	11.8(9.8-13.0)
Caudal Length	16.2	15.1(13.8-17.4)	-	-
Head Length	22.0	22.1(21.3-22.3)	24.9(23.4-26.1)	25.6(24.4-27.4)
Height of head (occiput)	8.7	9.4(8.7-10.4)	-	-
Height of head (eye)	8.6	8.9(8.3-9.8)	-	-
Snout Length	15.5	15.0(14.3-15.5)	-	-
Eye Diameter	2.2	2.4(2.2-2.6)	-	-
Inter-orbital space	1.3	1.8(1.3-2.0)	-	-
Inter-narial space	-	1.5(0.8-1.6)	-	-
Gape width	1.8	2.2(1.7-2.4)	-	-
Length of caudal peduncle	12.3	12.2(11.6-12.3)	-	-
Height of caudal peduncle	4.5	4.7(4.5-5.0)	-	-
Pre-dorsal length	48.9	48.9(47.8-50.0)	-	-
Post-dorsal length	50.1	49.9(49.6-50.1)	-	-
Pre-pectoral length	18.8	19.5(18.8-20.2)	22.4(20.4-27.8)	23.5(21.9-25.2)
Pre-pelvic length	50.4	53.7(50.4-55.0)	56.3(54.1-58.5)	57.8(54.5-59.2)
Pre-anal length	75.9	79.7(75.9-81.3)	79.9(78.8-83.4)	81.2(72.2-86.6)
Pre-anus length	71.6	78.4(71.6-103.6)	-	-
Max. head-width	6.5	7.4(5.7-8.1)	-	-
Head width (nares)	3.7	4.4(3.6-4.9)	-	-
Body width at dorsal origin	8.6	9.4(7.5-10.1)	-	-
Body width at anal origin	5.1	6.3(5.1-6.8)	-	-
Dorsal fin base length	11.0	12.4(11.0-13.0)	14.3(14.2-15.4)	14.4(12.7-16.1)
Dorsal fin height	11.2	12.5(11.2-13.0)	-	-
Anal fin base length	7.4	7.8(7.1-8.7)	7.9(5.5-10.5)	8.1(6.0-9.6)
Pectoral fin length	13.7	14.1(13.6-15.5)	16.7(14.3-20.5)	13.5(10.8-15.6)
Pelvic fin length	10.2	11.0(10.2-11.3)	9.5(8.5-14.5)	9.3(7.6-11.1)

rakers [18 vs. 21-27], shorter head length [22.0 (21.3-22.4) vs. 25.6 (24.4-27.4)% SL], shorter pre-pectoral length [19.5 (18.8-20.2) vs. 23.5 (21.9-25.2) %SL]. Sontirat (1999) examined as many as 180 specimens of *A. choirorhynchos* and found no dark blotches or spots on caudal and dorsal fins in larger specimens. However, the smaller specimens had small dark lateral spots and/or blotches on the sides and back, and some of these had three rows of small dark spots on the dorsal fin. The new species is also distinct from *A. choirorhynchos*, as described by Roberts (1989) by its longer head [head length 4.5-4.7 vs. 3.8 %SL], shallower caudal peduncle [caudal peduncle depth 19.9-22.4 vs. 22.3-23.0 %SL], greater numbers of vertebrae [43 vs. 42] and fewer dorsal fin rays [iii, 9½ vs. iii, 10½]. The new species also differs from *A. choirorhynchos*, as described by Day (1878) in its shallower body [body depth 9.3 (8.5-10.4) vs. 11.1 %TL], shorter head [19.2 (18.9-19.6) vs. 20.0 % TL] and caudal fin [caudal length 13.3 (12.1-14.7) vs. 16.7 %TL]; in having more blotches on sides of body [14-17 vs. 12], more saddles across the back [17 vs. 12], and more rows of blotches along dorsal fin [3 vs. 2]. The new species

Table 3: Comparison of *Acantopsis multistigmatus* sp. nov. with *A. choirorhynchos* Day (1878)

Characters	*A. multistigmatus* sp. nov.	*A. choirorhynchos* Day
Body depth (% of TL)	9.3(8.5-10.4)	11.1
Caudal length (% of TL)	13.3(12.1-14.7)	16.7
Head length (% of TL)	19.2(18.9-19.6)	20.0
Number of blotches at sides	14-17	12
Number of bands across back	17	12
Number of bands along dorsal	3	2
Number of bands across anal	Few irregular spots	3 rows of blotches
Fin counts	D. iii, 9½; P. i, 9-10; V. i,6; A. iii, 5½; C. 7+7	D. iii, 9; P. 11; V. 7; A. iii, 5; C. 11

has a few irregularly arranged spots across the anal fin, in contrast with the three rows of blotches in *A. choirorhynchos*. (The comparison is given in Table 3).

A. multistigmatus sp. nov. can be distinguished from *A. thiemmedhi* Sontirat by the colour pattern, 14-17 blotches vs. 8-9 irregular blotches on the lateral line, 17 vs. 8-9 saddles on the dorsal part of the body; a pattern of many small, transverse and horizontal wavy bars and spots arranged longitudinally up to the caudal peduncle region between the saddles and the blotches vs. only a row of broken horizontal wavy bars up to the posterior region of dorsal fin; 3 rows of black spots each on dorsal and caudal fins vs. 1 row and a blotch at first three dorsal rays and one large oblong dark bar near the middle part of each caudal lobe; body depth 10.9 (9.7-12.0) vs. 13.5 (12.3-15.2), pre-pectoral length 19.5 (18.8-20.2) vs. 22.4 (20.4-27.8), dorsal base length 12.3 (11.0-13.0) vs. 14.3 (14.2-15.4) all in % of SL, head depth 42.9 (39.7-46.3) vs. 58 (53.0-59.5), eye diameter 10.7 (10.1-11.7) vs. 14.9 (13.7-16.6) and snout length 68.0 (65.4-70.6) vs. 62.4 (57.9-64.1) all in % of head length. The new species also differs from *A. thiemmedhi* in its slightly emarginate caudal fin, as compared to bilobed one of the latter, larger size (103.2-181.0 mm vs. 46.7-122.8 mm) SL. (Comparisons are given in Tables 1 and 2). The percentage measurement of head depth, eye diameter and snout length provided by Sontirat (1999) is in percentage of head length and not in percentage of standard length as is printed.

A. multistigmatus is also distinct from *A. lachnostoma* Rutter in its caudal peduncle depth 4.7 (4.5-5.0) vs. 7.6 % SL, dorsal fin rays iii, 9½ vs. iii, 7½ and number of vertebrae 43 vs. 44.

Talwar and Jhingran (1991), Menon (1992) and Jayaram (1999) reported *A. choirorhynchos* to be widely distributed in the South-eastern Asian region. However, its distribution outside Borneo, Sumatra and Thailand region needs confirmation, as the description of the species from Thailand given by Sontirat (1999) does not fit into the description given by them. Three species of this genus from the Mekong have been reported as misidentified by Rainboth (1996) and are being kept as sp. 1, sp. 2 and sp. 3. The identity of *A. choirorhynchos* requires confirmation in view of the comment by Roberts (1989) that due to the paucity of systematic knowledge of this genus, statements on species distributions are not meaningful. As the drainage in which the hitherto known *A. choirorhynchos* of the Indian region is totally different from the type locality of the species, careful examination of the specimens is required for their correct identification.

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REVIEWS

1. BIRDS OF GOA: A REFERENCE BOOK, 2004. By Heinz Lainer. The Goa Foundation, Mapusa, Goa. 244 pp. (21.5 x 14 cm). Price: Hardback Rs. 500/-; Paperback Rs. 300/-.

As the subtitle indicates, this is a reference book and not a popular guide to the birds of Goa. I hope, one day, a more popular illustrated bird book of this small and ornithologically rich state will come out. The book is based on painstaking notes kept by Heinz for the last 20 years, and numerous unpublished reports of visiting bird watchers, especially Paul I. Holt and Gordon Frost. Heinz first published his annotated checklist on birds of Goa in the *JBNHS* in two parts (Vol. 96, 1999). This book is an updated version of that checklist — a welcome addition for serious bird watchers and ornithologists.

For listing, Heinz has followed the classification of Sibley and Monroe (1993), later used by Inskipp *et al.* (1996) and Grimmett *et al.* (1998), but he has added Synopsis numbers of Ripley (1982), thus helping both 'old' ornithologists familiar with Ali and Ripley's (1987) HANDBOOK classification, and 'new' bird watchers more familiar with the new classification. Each bird has common and scientific names, alternative name(s), if any, first record in Goa, status, habitats, sites where the species can be easily seen, population (mainly highest and lowest numbers recorded), breeding status, seasonal status (earliest and last sightings for migratory birds), and lastly remarks. Fairly good sketches by an upcoming artist, Sachin Jaltare, embellish the book. It also has published (55) and unpublished (96) references, list of names of places mentioned in the book, and index of common and scientific names.

Owing to its long colonial rule under the Portuguese, for a long time Goa remained unstudied. Unlike the British, the Portuguese were not interested in birds, especially uncooked ones! Nevertheless, the first recorded ornithological work was by P. Boddaert in 1783 in which he gave the type locality of the White-naped Woodpecker *Picus festivus* (= *Chrysocolaptes festivus*) and the Red-wattled Lapwing *Tringa indica* (= *Vanellus indicus*) at Goa. After Goa was merged with the Indian Union in 1961, the Zoological Survey of India conducted many studies between 1968 and 1978. In 1972, Dr. Sálim Ali and Dr. Robert Grubh collected about 150 birds of 100 species (Grubh and Ali 1976). Since the 1980s, Goa gained popularity among foreign tourists, and presently it is one of the favourite destinations for ornitho-holidays. With the advent of internet and e-groups, there is a plethora of trip reports, many of doubtful nature. Heinz has rightly warned in his preface against rushing to claim first sighting: "Goa abounds with families and genera of birds that do not have representatives in Europe and are therefore often totally baffling to the newcomer. Moreover, many common and not-so-common bird species of the Palaearctic occur as winter visitors in Goa, though often in the form of eastern subspecies that the European birdwatcher is not familiar with. Many visiting birders ....feel compelled to squeeze ....first sightings. Many of these often doubtful, sometimes absurd records find their way into unpublished trip reports."

With the publication of this authentic, well-researched book, I hope wrong identification will be avoided in future.

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2. THE MAMMALS OF ARUNACHAL PRADESH, 2003. By Anwaruddin Choudhury, Regency Publications, New Delhi. 140 pp. Price Rs. 400/- (15.5 x 23.5 cm)

Natural history is a subject to which both professionals and amateurs have contributed equally. Dr. Anwaruddin Choudhury is one of the finest amateur naturalists of India. He is an M.A. in geography and Ph.D. in primatology, but a civil servant by profession. He is a prolific writer. With an impressive list of more than 350 popular articles and scientific papers and eleven books, and his wide travel in the northeast, he is eminently suitable to produce the first ever checklist and systematic review of the mammals of Arunachal Pradesh, a state having the highest mammal diversity in India.

Arunachal Pradesh is a treasure-trove of mammalian fauna. There are very few areas in the world of the size of Arunachal Pradesh where more than 200 species of mammals could be found, and "another 38 species likely to occur or are recorded in adjacent areas." The systematic list contains Order, Family, generic name, English name, type locality, local name(s), distribution and status, subspecies, if any, and remarks containing useful information on morphological characters, protection status (in Indian Wildlife Protection Act), international status (CITES and IUCN categories). The book is based on thorough research — the bibliography consists of 25 pages. The oldest reference is a paper published in 1797 and the latest is 2002. Anwar is also an artist so he has used his own line-drawings. For major species, distribution maps are included, which further enhance the value of the book. The book is more suitable for professionals than amateurs. I wish we had such books for each state of India. I recommend it for all scientific institutes and universities conducting research on Indian wildlife.

■ ASAD R. RAHMANI

3. MARINE MAMMALS OF INDIA, 2004. By Kumaran Sathasivam. WWF and Universities Press, Hyderabad. Price Rs. 250 (21.5 cm x 14 cm)

Despite a coastline of nearly 7,000 km and an economic zone of 2.02 million sq. km, India's marine ecosystem has not been given the importance that it deserves. When we talk about conservation, we mostly mean terrestrial environment. The marine and fresh water environments have some of the most endangered and neglected fauna of India. The newly established REEF Watch, an NGO exclusively working for the protection of marine environment, is a welcome development. Hopefully, Kumaran Sathasivam's book will create more interest in "furthering understanding of and fostering concern for the marine mammals of India."

There are 120 species of marine mammals in the world, of which 32 are reported from the Indian waters, mainly belonging to Orders Cetacea and Sirenia. No marine member of the Order Carnivora is reported from the Indian seas. This easy-to-read book covers all the marine mammals found in India and is useful to both the amateurs and experts. It has some very interesting information. For instance, not many know that dolphin milk contains more protein and fat than cow's milk, and there was a proposal to set up a dolphin dairy farm. It was not known how to milk a dolphin!

After a brief introduction, a glossary and a chapter on classification and evolution of marine mammals, follows a chapter on Marine Mammal Research in India. Incidentally, there is hardly any research on the live marine mammals in India despite the fact that we have the Central Marine Research Institute, National Institute of Oceanography and marine biology is taught in many universities. The chapter on whaling makes sad reading and again highlights the destructive and selfish nature of human beings. Description of each species/groups is followed by brief chapters on some interesting phenomenon or behaviour, such as sound production in whales, intelligence of dolphins and mass stranding. Wherever necessary, sketches are given, but without labels. In this unconventionally designed book, page numbers are given halfway to the left or right side and the colour plates are inserted in the bibliography section!

The reference or bibliography section, called 'Source', consists of 16 pages and lists important research papers, relevant books, technical reports and even newspaper articles. To keep the text simple, references are not quoted in the text so there is no way to verify a statement or fact. Perhaps the references could have been numbered and numbers given in the text. Index of common and scientific names helps in finding a species easily in the text. Index of local names is also included (page 178), but most of these names are in Tamil and Malayalam. In future editions, Bengali, Marathi, Kannada and Gujarati terms should also be included.

On the whole, I find the book very useful and hope to see more such books on the other neglected ecosystems, habitats and taxa of India.

■ ASAD R. RAHMANI

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MISCELLANEOUS NOTES

1. USE OF ARM AS 'BRIDGE' IN GIBBON LOCOMOTION

While negotiating gaps in forest canopy, the Hoolock Gibbon *Hylobates* (=*Bunopithecus*) *hoolock* Harlan prefers to jump rather than coming down to the ground. However, when the gap is too wide, they come down and walk across, usually bipedal. Infants and juveniles are carried by their mother. I report an interesting observation on a juvenile crossing a gap in the forest canopy made in Borajan Reserve Forest (27° 25' N, 95° 22' E), now part of the Bherjan-Borajan-Podumoni Wildlife Sanctuary in Tinsukia district of eastern Assam.

On June 13, 1993 at 0315 hrs, a group of gibbons were located on a tree, where they were observed roosting the previous evening, to observe their daily activity pattern. A female and a juvenile in the group started moving by 0340 hrs. At 0415 hrs the female moved from her roosting position followed by the juvenile. At 0420 hrs, they reached a gap in the canopy. Since the juvenile was not carried by its mother, I was curious to see how it would cross the gap, which was easy for an adult, but not a juvenile. On reaching the gap, where the female was sitting, the juvenile called *eeke, kmm, kmm*, etc. The female without any hesitation pulled a branch of the tree on the other side of the gap while still sitting on the original tree. The juvenile then easily crossed over, using its mother's long arm as 'bridge', but instead of brachiation it crawled over the arm. Photography was not possible due to poor light.

I thank Jiban Chetia, Forest Guard and N. Malakar for their help during this study.

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2. ELECTRIC PYLONS USED AS NIGHT ROOST BY TROOPS OF RHESUS MACAQUE *MACACA MULATA* AT SARISKA TIGER RESERVE, ALWAR DISTRICT, RAJASTHAN

On May 12, 2001, around 2000 hrs, I was passing through the Sariska Tiger Reserve, when between Madhogarh and Bhrit-Hari crossing, I saw troops of Rhesus Macaque *Macaca mulata* roosting on two high-tension electric pylons close to the Alwar-Jaipur road. They not only roost on pylons at night, but rest on them during the day too. A similar night roosting behaviour was observed by me in the Hanuman Langur *Semnopithecus entellus* in Nahargarh Wildlife Sanctuary, nearly 70 km away from Sariska Tiger Reserve (*JBNHS* 99(1): 103).

Tiger (*Panthera tigris*) and Leopard (*P. pardus*), especially the latter, are the main predators of Rhesus Macaque in and around the Sariska Tiger Project area. Probably, to avoid the attack of a Leopard at night, troops of Rhesus Macaque prefer safer night roosts like high-tension electric pylons, which have towering heights. Since four vertically convergent iron angles, and many connecting criss-cross angles, provide a number of vantage points to sit and sleep to members of the troop, they opt for such places. Visibility remains good around the pylon, and predators like Leopard could be detected from a distance. Disturbances caused by stormy wind are also less on pylons than on crowns of trees.

Vertical and criss-cross angles are used as ladder to climb up. The latter are used as sleeping sites also. Angular points are much preferred for this. Congregation of animals can be seen at angular points, meeting points of two or more angles. When the macaques roost or rest on pylons, members of the troop face all the directions to keep a watch.

High-tension electric pylons are new roosting and resting sites of macaques in Alwar district. Before pylons became available, they roosted on tall trees and buildings only.

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3. TREND ANALYSIS OF MARKED LEOPARD *PANTHERA PARDUS* CAPTURED AND RECAPTURED AROUND GIR PROTECTED AREA, GUJARAT

One of the most important management practices in Gir National Park and Sanctuary is the rescue or capture of injured, distressed or problematic large carnivores like Lion (*Panthera leo persica*) and Leopard (*Panthera pardus*) which stray into peripheral villages and revenue areas (Singh and Kamboj 1996). The expert rescue teams from the Wildlife Division, Sasan-Gir, normally undertake the rescue or capture operation with the help of local staff. Although both lions and leopards are regularly rescued throughout the year from the peripheral villages, leopards pose a serious threat to the lives of the locals by straying very close to human habitation and attacking human beings (Prater 1997). A greater fear psychosis prevails from leopard movement than from the lions amongst the people in the areas surrounding Gir. The Gir PA management, after recognizing the threat, immediately acts to capture the straying leopards. The leopards rescued and captured in peripheral areas by the Forest Department are the ones responsible for human injury or death, and have created fear among the villagers due to regular movements in farms and residential areas, or those that have fallen accidentally into farm wells, be suffering from illness or injury.

Depending upon the field situation, trap cage with bait, ropes (for rescue from wells) or chemical tranquilization is used to capture the animal. The captured leopards are then brought back to the Wildlife Treatment Centre, where they are kept under observation or for treatment. After some time, the healthy animals are generally released into the core zone of the forest area (National Park). But before release, the animals are fitted with tags or microchips for identification and to record future recapture from other areas. The plastic ear tags are colour coded, serially numbered, and are in two identical halves, which are fixed to the ear using special pliers. The animal can be identified by its colour and the number can be read through binoculars. The microchips are placed at the base of the tail, between skin and muscle, subcutaneously. Each microchip has a distinctive number, which can be read by a machine. The numbers, with details of the captured animal, are recorded for future comparison. Microchips have an advantage over the tag method. The tag can be seen on the animals, and creates a fear psychosis among the locals, who think of marked animals as being problematic. Sometimes this leads to unpleasant situations during rescue operations.

Some leopards do not remain confined to their area of release due to unknown reasons and stray out again to the peripheral revenue areas of the Gir Forest. This study was intended to analyze the data on captured and recaptured animals to identify the problematic ones and to know their movement in and around the Gir PA. It is based on 38 cases of captured and released leopards during 2001 and 2002.

Findings

Thirty-eight leopards were captured from the areas surrounding Gir National Park and Sanctuary between April 2001 and February 2002. This included 19 females and 19 males. The age group of captured leopards ranged from *c.* 1½ to 13 years. Majority of animals (n=29, 76%) were adults i.e. more than 4 years of age. The captured leopards are mainly released in the core zone areas (mainly National Park) of Gir Forest like Miyakuan, Laptani and Patriara. Talala sub-district recorded the maximum — 12 leopard captures, followed by Una sub-district with seven cases. Rescues from other sub-districts are: Visavadar (3 cases), Sutrapada (4 cases), Kodinar (4 cases), Maliya (4 cases) Khamba (2 cases), Mendarda (1 case) and Ranavav (1case). It is known that majority of captures took place in the southern areas of Gir Forest, which may be due to extensive cultivation of sugarcane and presence of large tracts of mango orchard (Vijayan and Pati 2001). The majority of captures were mainly from farmlands (21 cases, five specifically from sugarcane), followed by farm wells (7 cases), villages (7 cases) and buildings (2 cases). The leopards that were caught from farmlands and villages were mainly due to fear among the people, but some were actually involved in attacks on human. Six leopards were involved in attacks on humans that took place in farmlands (2 cases), villages (2 cases), and buildings (2 cases). Two leopards were shifted to Sakkarbaug Zoo, Junagadh, due to cases of established human deaths. Majority of the rescued or captured leopards were healthy (95%) and only two cases had some injury related problems.

From the 38 leopards that were rescued from various areas and released into the core area of Gir forest, four animals were caught for the second time and one was captured for the third time (see Table 1). The period between release and subsequent recapture of leopard from other areas ranged from 11 days to six months. Leopards recaptured for the second time were mostly found from different areas, some were found very close to the earlier capture site. The distance between the site of first capture and subsequent recapture ranged from 2.2 km to 33 km. A leopard caught for the third

Table 1: Details of leopards captured and released more than once in and around Gir PA

Age & sex	First Capture		Released Forest area	Distance between capture and release site	Second Capture		Approximate period and distance between release site and 2nd capture	2nd release site (Forest area)	Distance between capture and release site	3rd capture and distance between 2nd release site	Distance from the place of second capture
	Subdistrict	Village (distance from PA)			Place (distance from PA)	Distance from first capture					
9 years Female	Talala	Ratidhar (18 km)	Patriara	28 km	Bhimdeval Talala (15 km)	2.2 km	11 days 28 km	Shivtali	38 km	—	—
5 years Male	Talala	Rasulpara (2 km)	Varvangda	13 km	Jasapur Talala (3 km)	2.7 km	5 months 18 km	Lapatani	22 km	Jasapur (20 km)	0 km
5 years Female	Sutrapada	Sutrapada Revenue (45 km)	Devakaniya	56 km	Vandarvad Maliya (25 km)	33 km	6 month 40 km	Miyakuan	44 km	—	—
9 years Male	Talala	Jasapur (2 km)	Junvaniya	18 km	Chatariya Mendarda (3 km)	25 km	1 month 27 km	Miyakuan	38 km	—	—
7 years Male	Maliya	Vandarvad 25 km	Devkania	51 km	Sukhpur Maliya (35 km)	13 km	1 month 47 km	Shivatali	54 km	—	—

time was recaptured from Jasapur (Talala subdistrict) where it had been caught earlier. The maximum distance travelled by a leopard, before being caught again, was 47 km (from Devkarnia (NP) to Sukhpur in Maliya subdistrict). Of all leopards that were recaptured from peripheral areas, two were involved in attack on humans, one had killed livestock, and the rest were captured due to fear and disturbances to humans.

In 1996, a male Leopard captured from a village farm well in Kodinar sub-district and subsequently tagged and released inside the forest area, had migrated to Dharoi village in Mehsana district (North Gujarat), where it was shot inside a house by the Police Department for the safety of people. The leopard had travelled 340 km (within 8 months) from the area of release.

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We thank the rescue team members and local field staff of Gir for their exemplary work in conserving important flagship species like lions and leopards. We also thank Shri B.J. Pathak, Conservator of Forests, Wildlife Circle, Junagadh for his comments and suggestions.

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4. SPECIES OF BARKING DEER (GENUS *MUNTIACUS*) IN THE EASTERN HIMALAYAN REGION

The barking deer or muntjacs are small, solitary, cryptic forest dwellers found throughout southern and eastern Asia from India through China, Indochina, and Malaysia, to Indonesia. Two species have long been known from the eastern Himalayan region. The Red Muntjac (*Muntiacus muntjak*) is relatively common and widely distributed, whereas the Chinese or Reeves' Muntjac (*M. reevesi*) is confined to southeast China, east of about 100° E. During the 1990s the discovery of two new muntjac species and the rediscovery of a third species in the Annamite Mountains along the Lao-Vietnam border focused attention of zoologists on this ancient lineage of cervids (Groves and Schaller 2000, Amato *et al.* 2000). In 1997, yet another new species was discovered in Myanmar (Burma) and named Leaf Deer (*M. putaoensis*) by Rabinowitz *et al.* (1999). That year, the Black Muntjac (*M. crinifrons*), previously known only from China, was also found in Myanmar, extending its recorded range by about 1,750 km (Rabinowitz and Khaing 1998, Rabinowitz *et al.* 1998). Although the Leaf Deer and Black Muntjac were each initially found only within small areas, our recent work has shown these species to have a much more extensive distribution. The purpose of this note is to describe their known geographic range and point to their possible occurrence in India and elsewhere in the eastern Himalayan region.*

Leaf Deer (*Muntiacus putaoensis*)

The Leaf Deer, so named because local hunters wrap their kill into large *Phrynium* leaves, is a diminutive fawn-coloured muntjac, weighing about 12 kg, with spike antlers in males up to 5 cm long. The conspicuous canines are of the same size in males and females, an unusual condition in muntjacs (Rabinowitz *et al.* 1999). It was discovered in secondary and old-growth evergreen broad-leafed forest northeast of Putao in northern Myanmar (26° 58' N, 96° 09' E) at elevations of around 800-2,000 m (Rabinowitz and Khaing 1998, Rabinowitz *et al.* 1999). Analysis of its mitochondrial DNA confirmed it as a new species most closely related to two other small muntjacs (*M. rooseveltorum*, *M. truongsonensis*) in the Annamite Mountains (Amato *et al.* 2000). We now have additional specimen records from the Hponkan Razi area (27° 30' N, 97° 09' E), the Hukaung valley (26° 58' N, 96° 09' E), and near the Saramati massif (25° 42' N,

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*This note was submitted for publication in March 2002. In it we predict that two muntjac species new to India might occur within its borders. One of these was discovered in November 2002. See, Aparajita Datta *et al.* 2003, Discovery of the Leaf Deer *Muntiacus putaoensis* in Arunachal Pradesh an addition to the large mammals of India. *Current Science 84*: 454-458.

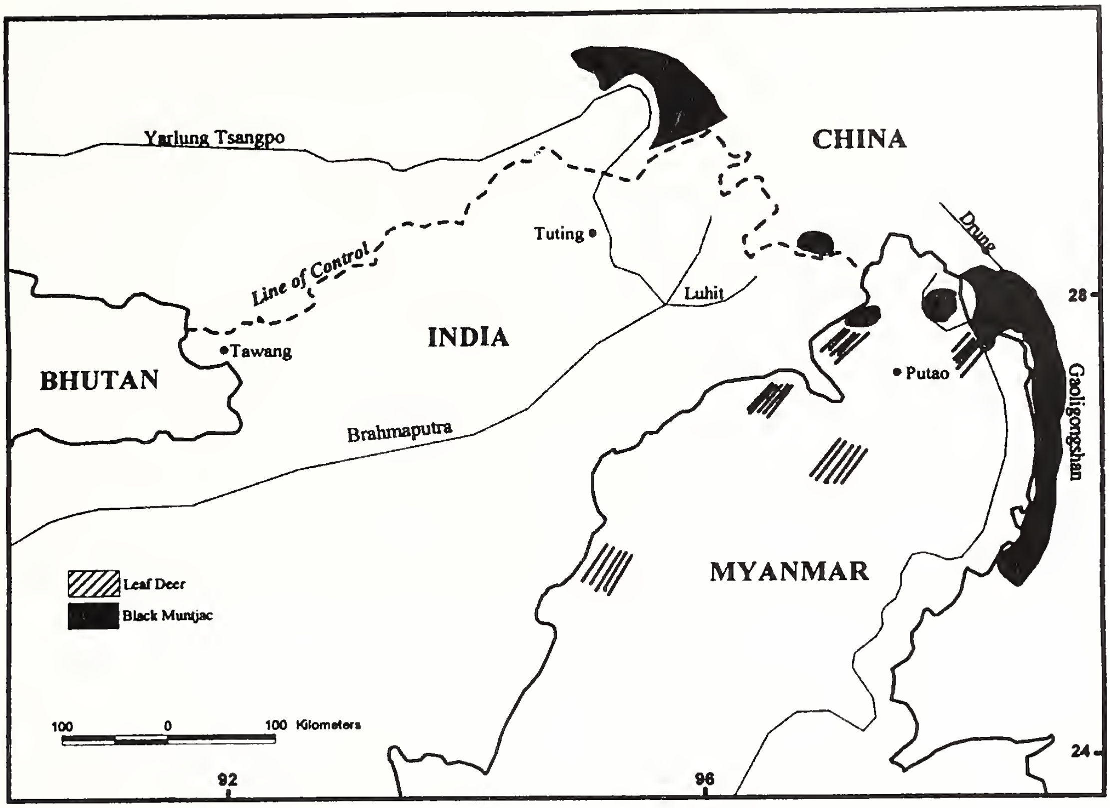

Fig. 1: Known distribution of two muntjac species – Leaf Deer and Black Muntjac – in the eastern Himalayan region

95° 13' E), all close to the Myanmar-India border (Fig. 1). These records suggest that the species occurs or once occurred within Indian limits, especially in the southern part where high mountains do not block movements. Leaf Deer are also said to extend into north-central Myanmar (26° 25' N, 97° 30' E) "west and northwest of Sumpra Bum" (Mg 2001). There is a vague report from China from the southern part of the Gaoligongshan in Yunnan between about 24-25° N where Ma *et al.* (1994) describe "a possible new species of small muntjac". These mountains border Myanmar and are relatively low at that latitude, providing an immigration route. The Leaf Deer may thus have a fairly wide distribution in the northern third of Myanmar and the areas of India and China immediately bordering that region.

Black Muntjac (*Muntiacus crinifrons*)

In the past, Black Muntjacs were known only from parts of the Anhui, Zhejiang, Fujian, and Jiangxi provinces of eastern China. About the size of a Red Muntjac, the species weighs 21-26 kg (Sheng 1992). Its coat colour is variable, ranging from brown with a chestnut hue or grey-brown to dark brown with blackish legs and white undersides. The antlers are usually small, 4-6 cm long (Sheng 1992), and without the terminal hook as often found in adult male Red Muntjac. In 1988, a supposedly new species of muntjac (*M. gongshanensis*) was found in the Gaoligongshan in Yunnan, China (Ma *et al.* 1990), but detailed analysis of the mitochondrial DNA revealed that the animal is actually *M. crinifrons*, far outside its known range (Amato *et al.* 2000). In the Gaoligongshan, the Black Muntjac is said to occur along most of that range from near the border of the Tibet Autonomous Region (28° 10' N) south to about 25° N (Ma *et al.* 1994). Rabinowitz and Khaing (1998) then discovered this species in Myanmar in the forested hills north of the banks of the Nam Tamai (about 27° 50' N, 97° 50' E). In 2002, we found it near the Myanmar-India border at 27° 43' N, 97° 05' E (Fig. 1). During surveys of southeast Tibet in 1998 and 2000, we discovered two other disjunct populations of Black Muntjac. One population is located along the Pailong and Yigong rivers (30° 07' N, 95° 02 E), both tributaries to the Yarlung Tsangpo, which becomes the Siang as it enters India, and in the Medog area to the south (Schaller *et al.* 2000). The other is located to the east near Zayu where a specimen was obtained at 29° 56' N, 94° 48' E.

Black Muntjac inhabits primarily broad-leafed evergreen and semi-evergreen forests in hilly to mountainous terrain, a habitat also often occupied by Red Muntjac. Both species, so similar in size, occur in the Gaoligongshan, but an ecological separation, if any exists, has not been described there (Ma *et al.* 1994). Only the Black Muntjac is found in far northern

Myanmar (Rabinowitz and Khaing 1998). However, farther south, we noted that Black Muntjacs are mainly above 1,500 m, extending sparsely up into the temperate forest at least to 2,600 m, whereas Red Muntjac occurs at lower elevations. In south-eastern Tibet, Black Muntjacs were at 1,800-2,600 m and Red Muntjac lower down (Schaller *et al.* 2000). We had found that the Capped Leaf Monkey (*Trachypithecus pileatus*) has penetrated northward from the mountain forests of Arunachal Pradesh in India into the big bend of the Yarlung Tsangpo in Tibet, and we expected a similar distributional pattern in Black Muntjac. One of us (GBS) visited Arunachal Pradesh on an ecotourism assignment in 2000. Local hunters characteristically hang trophies on the walls of their home. Many muntjac specimens were examined along the Luhit river, Siang river as far north as Tuting, around Tawang (Fig. 1), and elsewhere. All were Red Muntjacs even at high elevations, and near Tawang one animal of this species was observed at 3,000 m, higher than any elevation reported for Black Muntjac. Possibly the Black Muntjac reached southeast Tibet via a northern route, bypassing India. But a more widespread search for the Black Muntjac is required before its distributional dynamics can be discussed with confidence.

The evidence suggests some degree of competition and ecological separation between Red and Black Muntjacs, species with a long, separate evolutionary history judging by their DNA (Amato *et al.* 2000). The Black Muntjac may have evolved somewhere in China and entered Myanmar from the northern Gaoligongshan, bypassing the high mountains via the Drung (Tarong) river valley, or via the low-lying southern part of this range. Considering the distribution of the two species in China and India, the Red Muntjac may have colonized a vast area first and the Black Muntjac later moved into sparsely occupied terrain, or the Black Muntjac survives in the eastern Himalaya as relic populations at high elevations with the Red Muntjac having become dominant.

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5. ON THE PANGOLIN AND PORCUPINE SPECIES OF BANGLADESH

There seems to be some confusion as to which species of porcupine and pangolin occur in Bangladesh. The country is located on the eastern fringe of the distribution of the Indian pangolin *Manis crassicaudata* and Indian porcupine *Hystrix indica*. The western / south-western limit of the Chinese pangolin *Manis pentadactyla* and crestless Himalayan porcupine *Hystrix brachyura* is also in this region. It is because of this transition that the confusion prevails.

Khan (1985) mentioned that *M. crassicaudata* occurs widely, but in small numbers in areas bordering northeast India as the main range. He doubted presence of *M. pentadactyla* in eastern areas, but mentioned no sight record. From my field survey experiences in north-eastern India, especially near the Indo-Bangladesh border in

Meghalaya, Assam and Mizoram, I could not find any evidence of *crassicaudata*, but *pentadactyla* was common all over. This clearly indicates that the pangolins of northern Mymensingh, Sylhet and Chittagong Hill Tracts are *pentadactyla* and not *crassicaudata*. The animals from west of Padma-Meghna rivers (the conspicuous zoo-geographic barrier in the region) are apparently *crassicaudata* as it has been recorded from the adjacent districts of West Bengal (Agrawal *et al.* 1992).

Khan (1985) mentions that *Hystrix indica* occurs widely and was earlier common in the entire country. But the photo accompanying his text was that of *H. brachyura* and certainly not *indica*. Here again, my field experience near the Indo-Bangladesh border in Meghalaya, Assam and Mizoram indicated that porcupines of northern Mymensingh, Sylhet and Chittagong Hill Tracts are *brachyura* and not *indica*. Again the animals from west of Padma-Meghna rivers (the conspicuous zoo-geographic barrier in the region) are apparently *indica* as it has been recorded from the adjacent districts of West Bengal (Agrawal *et al.* 1992).

These mistakes have been repeated in Islam *et al.* (2000). One reason for such mistakes was not seeing the specimens or not examining them critically, or simply relying upon local reports without cross-checking as is evident in some works in northeast India (Chatterjee 1989, Chetry *et al.* 2001, Singh *et al.* 1994). The camera-trap record of porcupines in Kaziranga (Karanth and Nichols 2000) was also of the Crestless Himalayan Porcupine *Hystrix brachyura* and not Indian Porcupine *Hystrix indica* as mentioned.

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6. CAT SNAKE *BOIGA TRIGONATA* IN DIET OF JERDON'S BAZA *AVICEDA JERDONI*

Jerdon's Baza *Aviceda jerdoni* is one of the least studied raptors in India. It is distributed in northern West Bengal, Sikkim, Assam, North-eastern hill states, hills of Karnataka, Kerala, Tamil Nadu, Eastern Ghats and Andhra Pradesh, and affects tropical moist-deciduous to broadleaved evergreen forest (Ali and Ripley 1983; Grimmett *et al.* 1998; Kazmierczak 2000). Its diet consists of lizards, frogs, grasshoppers, and other large insects (Ali and Ripley 1983; Grimmett *et al.* 1998), birds eggs (Grossman *et al.* 1965) and a record of a small snake (del Hoyo *et al.* 1994). Crabs, bats, mice, shrews and rarely birds are recorded in the diet of other equal sized bazas found in different parts of the world (Grossman *et al.* 1965).

During the study on the breeding of the Jerdon's Baza in Buxa Tiger Reserve, West Bengal, two cat snakes *Boiga trigonata* were recorded along with its normal diet of insects, frogs and calotes lizards. The snakes, *c.* 50 cm long, were brought to the nest on different occasions during the third week of the nesting period. Adults fed small pieces of the snakes to the nestlings and consumed the thin tail portions themselves. This observation indicates that snakes are probably a part of the Jerdon's Baza's regular diet.

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7. OCCURRENCE OF THE NORTHERN GOSHAWK *ACCIPITER GENTILIS* IN AND NEAR MYSORE, KARNATAKA

The Northern Goshawk *Accipiter gentilis* is considered a rare winter visitor to north India, straggling to Gujarat and Sind (Ali and Ripley 1987). It has been recorded from Bhavnagar (Dharmakumarsinhji 1954) and Hingolgadh (Khacher and Mundkur 1989) in Gujarat, Poona (Ingalhalikar *et al.* 1987) in Maharashtra and up to Bangalore, Karnataka (Prasad and Karthikeyan 1994) and Wynaad, Kerala (Zacharias and Gaston 1993) in south India.

A solitary male bird of this species was observed at Gujjegowdanapura (12° 5' N, 76° 31' E) on January 1, 2000 in an undulating, hilly area with patches of scrub forest, a eucalyptus plantation and several scattered trees of *Acacia nilotica*, *A. leucophloea*, *Casuarina equisetifolia*, *Terminalia chebula*, *Strychnos potatorum* and *Mangifera indica*. The location is roughly 22 km southwest of Mysore city (12° 18' N, 76° 33' E). The bird was seen resting at 1600 hrs in a cluster of *Acacia* trees at the border of a gram field close to Gujjegowdanapura lake. The large size, sooty black cap and face, distinct white supercilium, slaty grey upperparts and white underparts, finely barred black, readily identified the bird as a male *A. gentilis*.

Juveniles of this species were observed on two occasions at separate locations. The first of these sightings took place at Meenakshipura on the south bank of the Krishanarajasagara reservoir (12° 24' N, 76° 26' E), 24 km northwest of Mysore city, on January 8, 2000. A large *Accipiter* raptor was seen as it took off from a well-wooded area close to dry land cultivation. It was mostly brown in colour, with bold, dark, vertical streaks on dirty creamy-buff underparts and a barred tail. In flight, its rounded wings, mode of flight and characteristic barring on the underwing identified it as a juvenile Northern Goshawk. The bird was observed in pursuit of a Black-naped Hare *Lepus nigricollis* across a short stretch of open field, and successively through a thick patch of *Cassia* sp. and *Pongamia glabra* trees lining a streambed. It successfully caught the hare after a masterly display of deft twisting, turning and ducking through the narrow path, matching and finally overcoming the hare's tactics in escape.

The second sighting of a juvenile was on February 30, 2001 at the foot of Chamundi hill in Mysore city. The bird was observed in a *Eucalyptus* grove bordering thick scrub vegetation of *Ziziphus jujuba*, *Z. oenoploea* and *Dichrostachys cinerea*. It was also observed in flight, and was constantly mobbed by a band of *Turdoides affinis*.

These sightings and those of Zacharias and Gaston (1993) and Prasad and Karthikeyan (1994) indicate that the Northern Goshawk is possibly a rare winter visitor to southern India.

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8. THE EASTERN IMPERIAL EAGLE *AQUILA HELIACA* NEAR MYSORE, SOUTHERN INDIA

The Eastern Imperial Eagle *Aquila heliaca* Savigny 1809, listed as a globally threatened (Vulnerable) species (BirdLife International 2001), is considered to be a "rare resident, but mainly winter visitor" to western Pakistan, North and Northwest India up to Gujarat in the south (Ali and Ripley 1987). It has been recorded regularly in winter from Nepal and occasionally from West Bengal and Assam in eastern India, Bangladesh and Bhutan (BirdLife International 2001). There are a few published records of the bird from the central and southern parts of the peninsula – an adult was observed at Nandur-Madhmeshwar in the Nashik district of Maharashtra in 1983 (Goenka *et al.* 1985) and one at the Vedanthangal Bird Sanctuary in Tamil Nadu in 1991 (Anon. 1991).

An adult bird of this species was observed by one of the authors (Shivaprakash. A) at Bilikere (12° 19' N, 76° 27' E), a moderate-sized irrigation tank situated 27 km west of Mysore city (12° 18' N, 76° 33' E), on the Mysore-Mangalore highway, on January 28, 2001 at 1530 hrs. The bird was initially observed on a 'Jaali' (*Acacia nilotica*) tree on the lake shore and identified by the white scapular 'patches' on the large, dark brown body and the pale, buff head and nape. When it took off, fully feathered tarsi and light greyish-brown tail with a terminal band were visible. Wings were held flat when the bird began to soar, much more so than the Greater Spotted Eagle *Aquila clanga,* which is usually seen at the lake and was present at the time of this sighting. In flight, underside was a dark brown body without the white/buff under-tail coverts of spotted eagles. The take-off and initial flight appeared to be sluggish and laboured, but once soaring, the bird gained an effortless manner.

The bird was observed again at the Lingambudhi lake (12° 16' N, 76° 37' E) on the outskirts of Mysore city on February 25, 2001 at 1010 hrs and could have possibly been the same individual. The diagnostic scapular patches were visible, confirming its identity. Both the sites are lakes situated in dry lands, with irrigation being limited to the *ayacut* of small irrigation tanks that dot the countryside.

These sightings represent the second report of the bird from south India. Although Ali and Ripley (1987) state that "…how much further east or south uncertain due to records being vitiated by confusion in field identifications", it is possible to separate the *Aquila* eagles in field with practice, but it is always prudent to exercise caution, as contended by Ali and Ripley, in case of uncertainties. The advent of newer, better illustrated field guides with sufficient good pointers to plumage details, flight patterns, adult and juvenile phases has certainly helped improve identification.

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9. STATUS OF THE GREATER SPOTTED EAGLE *AQUILA CLANGA* PALLAS IN THE WETLANDS OF THE KAVERI BASIN OF KARNATAKA

The Greater Spotted Eagle *Aquila clanga* is a globally threatened species, categorized as "Vulnerable" (Collar *et al.* 1994, BirdLife International 2001). Previously described as a rare winter visitor to the southern peninsula (Ali and Ripley 1987), the status of the species has undergone a change in the light of new reports (Perennou 1989, Santharam 1999) and can now probably be regarded as a localized winter visitor, not uncommon in parts, based on new evidence (BirdLife International 2001, George 1994, Grimmett *et al.* 1998, Perennou 1989, Santharam 1999, Aasheesh Pittie *pers. comm.*). This note is based on the results of a survey in the wetlands of the Kaveri basin in southern Karnataka state.

The Kaveri Basin: It covers an area of 81,155 sq. km over the three southern states of Karnataka, Kerala and Tamil Nadu, of which 34,272 sq. km lies in the districts of Bangalore, Chamarajanagar, Kodagu (Coorg), Hassan, Mandya, Mysore and Tumkur in southern Karnataka (Dikshit *et al.* 1993). The basin is drained by the Kaveri river and its tributaries, significant among which are Kapila (Kabini), Hemavathi, Lakshmanathirtha, Shimsha, Harangi, Suvarnavathi and

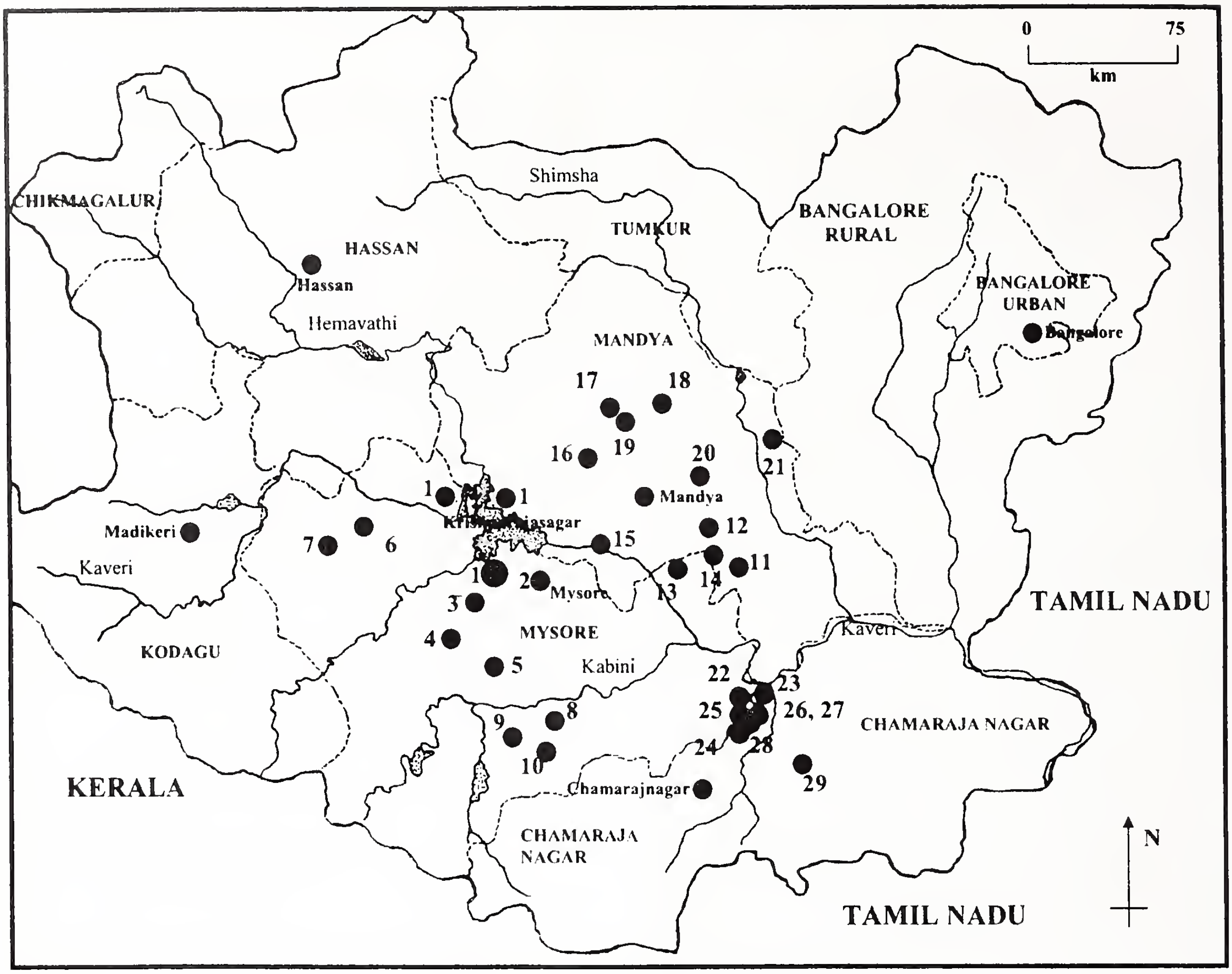
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Fig. 1: Sightings of *Aquila clanga* in Kaveri Basin, southern Karnataka

Arkavathi. Three major dams, the Krishnarajasagar, the Kabini and the Hemavathi (Gorur) have been built on these rivers. 13,133 of the 36,598 irrigation tanks (known as *kere* in Kannada) in Karnataka lie in the Kaveri basin (Dikshit *et al.* 1993). Thus, there is a large network of wetlands including paddy fields and canals.

Results of a general survey of large tanks and reservoirs in the basin, with waterspread area > 75 hectares, for the Greater Spotted Eagle in 1996-2002 revealed the species to be present at twenty-nine sites that include two riverine sites (see Table 1 and Fig. 1). Identification difficulties are cited as one of the reasons of the species being under- or over-recorded from certain areas (BirdLife International 2001) and only confirmed sightings are reported here after thorough verification.

These observations indicate that the lakes of the Kaveri basin in Karnataka are an important wintering ground for the Greater Spotted Eagle in southern India. It has also been observed that the Greater Spotted Eagle is very parochial to its wintering grounds, without much movement which, if any, is restricted to nearby lakes.

Krishnarajasagar reservoir: It is located 18 km from Mysore city over Mysore and Mandya districts and covers an area between 125 sq. km at full capacity (124.80 feet) and 15-20 sq. km at dead storage. Annual waterfowl counts indicate that at least 25,000-29,000 waterfowl winter at this site regularly (AWC 1996-2002).

At least six adult birds have been observed to winter in different parts of the reservoir in 1997-2002, making it the most important site known for the species in southern India at present. Three birds can be seen in the Hampapura-Manchanhalli floodplain marshes on the western bank, two at Ayarahalli backwaters on the south-western bank and one at Bookanakere on the northern bank of the reservoir. An adult bird was observed to dive from a height of *c.* 122 m (400 ft) to catch an injured Ruff *Philomachus pugnax* on 28.xii.2000. A pale '*fulvescens*' juvenile was observed in October 2001-March 2002 at Hampapura.

Table 1: Sightings of the Greater Spotted Eagle in the Kaveri Basin, Southern Karnataka

Site Name	Geographical Location	Years of sightings	Number of Adults observed	Number of Subadults/ Immature birds	Number of Juveniles observed	Site number in map
Krishnarajasagar Res.	12° 24' N, 76° 26' E	1997-2002	6	-	1 (*fulvescens*)	1
Lingambudhi lake	12° 16' N, 76° 37' E	1996-2002	2	-	1 (*fulvescens*)	2
Bilikere lake	12° 09' N, 76° 27' E	1999, 2001	1	-	-	3
Nagapaiahanakere lake	12° 13' N, 76° 22' E	2000, 2001	1	-	-	4
Karigala lake	12° 08' N, 76° 25' E	2001	1	-	-	5
Ravandur lake	12° 26' N, 76° 12' E	2000, 2001	1	1	-	6
Periyapatna Doddakere lake	12° 20' N, 76° 05' E	2000	1	-	-	7
Narasambudhi lake	12° 05' N, 76° 43' E	1998-2002	1-2	-	-	8
Kalale lake	12° 04' N, 76° 39' E	1999, 2000	1	-	-	9
Sindhuvalli lake	12° 03' N, 76° 41' E	2000, 2002	1	-		10
Kaggalipura lake	12° 16' N, 76° 53' E	2001	1	-	-	11
Markal lake	12° 23' N, 76° 58' E	1999, 2000	1	-	-	12
Chamanahalli lake	12° 20' N, 76° 53' E	2000	1	-	-	13
Bannur Heggere lake	12° 20' N, 76° 57' E	2002	1	-	-	14
Ranganathittu BS*	12° 25' N, 76° 39' E	1999	1	-	-	15
Thonnur lake	12° 30' N, 76° 40' E	1998	1	-	-	16
Kowdle lake	12° 44' N, 76° 43' E	2000	1	-	-	17
Chandagalu lake	12° 42' N, 76° 44' E	2000	1	-	-	18
Koppa lake	12° 42' N, 76° 57' E	1999	1	-	1 (*fulvescens*)	19
Sulekere lake	12° 40' N, 76° 50' E	2000-2002	-	1	-	20
Tailur lake	12° 36' N, 77° 05' E	2001	1	-	-	21
Kunthur lake	12° 07' N, 77° 02' E	1996-2002	1-2	-	1	22
Kallur lake	12° 09' N, 77° 03' E	1998, 2001-2002	1	1	1 (*fulvescens*)	23
Yelandur lake	12° 03' N, 77° 01' E	2000-2002	1-2	-	-	24
Yeriyur lake	12° 04' N, 77° 02' E	1999, 2002	1	-	-	25
Kesthur lake	12° 05' N, 77° 01' E	2000-2002	1-2	-	-	26
Maddur lake	12° 05' N, 77° 02' E	1998, 1999	1	-	-	27
Agara lake	12° 06' N, 77° 04' E	2000	1	-	-	28
Honganur Hirikere lake	11° 57' N, 77° 04' E	2000-2001	1	-	-	29

Kunthur and Kallur lakes: These lakes, adjacent to each other, have a combined waterspread area of around 500 hectares and are located around 52 km southeast of Mysore, near Kollegal town in the Chamarajanagar district. They host between 35,000 and 55,000 waterfowl every winter (AWC 1992-2002) and attract a wide range of birds of prey, including three to four Greater Spotted Eagles every year since 1996. A juvenile bird was seen in the winter of 2000-2001.

Lingambudhi lake: It is located on the outskirts of Mysore city and covers an area of 76 hectares. One to two birds seen regularly at the lake since 1996. A pale '*fulvescens*' juvenile was observed in winter 2001-2002. Diet of an adult observed in 2001-2002, included Garganey *Anas querquedula*, Wood Sandpiper *Tringa glareola*, Purple Moorhen *Porphyrio porphyrio*, frogs *Hoplobatrachus tigerinus* and *Euphlyctis hexadactylus*.

Narasambudhi lake: It is situated 27 km south of Mysore near Nanjangud town in Mysore district; covers an area of 840 hectares and is one of the largest tanks in the region. One to two birds seen every year at the lake (Table 1).

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10. THE WHITE-BELLIED SEA-EAGLE *HALIAEETUS LEUCOGASTER* (GMELIN) IN INLAND SOUTHERN INDIA

The White-bellied Sea-Eagle *Haliaeetus leucogaster* (Gmelin 1788) is a breeding resident of the seaboard and offshore islands from Bombay (=Mumbai) down the west coast and up east up to E. Pakistan (now Bangladesh) (Ali and Ripley 1987). It is also "...Occasionally met a few miles inland along tidal rivers and at freshwater lakes..." (Ali and Ripley 1987). The only records of the bird from inland areas in India are from Ahmedabad, *c*. 80 km from the sea coast (Acharya 1936) and one at the mouth of Shatrunji river, Saurashtra (Ali and Ripley 1987).

A White-bellied Sea-Eagle was observed at Maddur lake (12° 5' N, 77° 2' E), a large irrigation tank, with a water-spread area of some 1,500 acres near Yelandur town in Chamarajnagar of south Karnataka on January 23, 2000, nearly 400 km from either coast. The bird was easily identified by its pure white head and underparts, grey upperparts, white wings with black flight feathers and a white, wedge-shaped tail with a black base. It was seen soaring above the lake and made a spectacular dive from *c*. 100 m to catch a large fish. The bird then consumed the fish leisurely atop an *Acacia nilotica* tree on the lake shore.

This is the first record of the bird from inland southern India, and the farthest the bird has been recorded from the sea shore in India.

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11. A NOTE ON HARRIER ROOSTS IN THE MYSORE AREA

This note records the presence of three minor harrier roosts in Mysore and Chamarajanagar districts of southern Karnataka. The Mandakhalli Airport (12° 13' N, 76° 39' E) is located *c*. 8 km south of Mysore city (12° 18' N, 76° 33' E). The Mandakhalli airfield, in parts an open expanse of grassland, serves as a roost site for harriers. 73 harriers, including 27 Pallid Harriers *Circus macrourus* (16 males, 6 females and 5 juveniles) and 46 Montagu's Harriers *Circus pygargus* (39 males and 7 females) were observed on January 12 and 14-16, 2002, mostly at dusk. This is the third such roost we have observed in the Mysore, Mandya and Chamarajanagar districts, defined here as the Mysore area, of southern Karnataka. A roost of 37 harriers, 17 Pallid, 13 Montagu's, 6 Western Marsh *Circus aeruginosus* and a juvenile Pied Harrier *C. melanoleucos* (only in 2000-2001) were observed between November 2000-March 2001 and November 2001 till this note was accepted, at the Yedathore bank of the Kaveri river. This area is open ground, i.e. located at the point where the Kaveri river enters the Krishnarajasagara reservoir (12° 24' N, 76° 27' E) and close to a state highway. Another roost exclusively of the *C. aeruginosus* was located at the Yelandur lake (12° 3' N, 77° 2' E), 65 km southeast of Mysore city. In January 1998, 67 individuals of *C. aeruginosus* were counted on fallow paddy fields close to the lake. But in subsequent years, cultivation of this area led the harriers to abandon the roost. Reports of harrier roosts from India have been few, and although major sites have been identified (Clarke 1996, Rahmani and Manakadan 1987, Satheesan and Rao 1990), much work remains to be done to identify the smaller, perhaps more numerous sites (Prakash 2001).

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12. OCCURRENCE OF AMUR FALCON *FALCO AMURENSIS* RADDE AND LESSER KESTREL *FALCO NAUMANNI* FLEISCHER IN MYSORE, KARNATAKA

The Amur Falcon *Falco amurensis* and Lesser Kestrel *Falco naumanni* were observed in an open expanse of grassland at the Mandakhalli Airport area (12° 13' N, 76° 39' E), *c.* 8 km south of Mysore city (12° 18' N, 76° 33' E) on January 12 and 14, 2001. On the 12th, SS saw a few kestrels at a distance at the Mandakhalli lake nearby, while he was conducting a waterfowl census. He counted a total of thirteen birds, and since it was unusual for kestrels to congregate, he attempted further investigation but could not confirm the identity of the birds. On the 14th, shortly after dawn, we observed several hundred Amur Falcons take off from eight *Acacia nilotica* trees along the periphery of the airfield. They took off singly first, then in twos and threes and finally in small groups of up to seven birds. The estimated number of birds was around 550, the male:female ratio being approximately 60:40. The male was identified by its unmistakable sooty grey body, with rusty red vent and legs. In flight, the white underwing coverts contrast with grey primaries and secondaries. In the female, grey upper-parts, white throat and collar, a blackish stripe on the cheeks, and markings on the underside – longitudinal spots on the chest and lateral barring further down to the abdominal region. The presence of Lesser Kestrels was discerned after light conditions improved, but they were fewer in number than Amur Falcons. We counted 89 birds, of which 56 were males and rest females. Males were readily identifiable by their unmarked bright brown mantle and back, a grey sub-terminal band to the wings, relatively unmarked chest and absence of a cheek-stripe. Paler claws vis-à-vis the Common Kestrel *Falco tinnunculus*, was noted for both sexes using a 15-45 x 60 spotting scope. Females were similar to Common Kestrel females, which differed in having dark claws. After light conditions improved, we could observe these small falcons better. They kept flying about in scattered flocks for around fifteen minutes after leaving the roost, but slowly spread throughout the entire airfield and further. Most of them moved away in a southerly direction, but 35 *F. naumanni* remained behind. The individuals were mostly males and were spread widely in the airfield. In the evening, at 1730 hrs, we could see most of the Amur Falcons and Lesser Kestrels settling in the *Acacia* trees rather noisily, swarming around the trees, frequently dashing in the air as if catching something, just like bee-eaters. Ali and Ripley (1978) recorded similar behaviour for the birds as they settle to roost. The birds were present well before sunset and began to group-up just after. They were present the following morning, but did not return in the evening, or for the next two days. We assume that by then they had left the area completely.

Amur Falcon is described as a passage migrant, with occasional breeding records from N. Cachar, now in Assam (Ali and Ripley 1978), but none in the past several decades. It has been recorded as on passage at several points in peninsular India, which Ali and Ripley (1978) refer to as 'stragglers'. This sighting is the second for Karnataka after more than a century; the last published report goes back to 1898 in Karwar (Davidson 1898).

Lesser Kestrel is listed as an endangered species in the BirdLife International Red Data Book on Asian birds (BirdLife International 2001). Ali and Ripley (1978) write for *Falco naumanni*, "Status uncertain. Apparently rare winter visitor; perhaps more correctly as an irregular through passage migrant to E. Africa like the Red-legged Falcon, a few stragglers remaining behind." It has been obtained as thus from several locations in a wide area of north and north-eastern and peninsular India, up to the Nilgiris in the south. It has also been observed in the Maldives (Ali and Ripley 1978). In more recent times, it has been recorded from Corbett National Park, Uttaranchal (Naoroji 1999), Kaziranga National Park, Assam (Barua and Sharma 1999) and Wynaad, Kerala (Zacharias and Gaston 1993) in India, Dera Ismail Khan district in northwest Pakistan (Kylanpaa 2000) and from Sri Lanka (Hoffmann 1996). There is a reliable but unpublished record of the bird from the Biligirirangan Hills in south Karnataka (Srinivasa *et al.* unpublished). Ali and Ripley (1978) mention *F. amurensis* and *F. naumanni* migrating together. Arjal (1976) records the same from Nepal, and our sighting corroborates it.

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13. NATURAL HISTORY NOTES ON CHICKS OF THE NICOBAR MEGAPODE *MEGAPODIUS NICOBARIENSIS*

The Nicobar Megapode *Megapodius nicobariensis* is one of the 22 species of megapodes and is endemic to the Nicobar Islands, India. Megapodes are a unique group of birds as they utilise external sources of heat to incubate their eggs (Jones *et al.* 1995). Superprecocial chicks of megapodes hatch at depths from *c.* 20 cm to 1 m or more from the incubation site (Jones *et al.* 1995). In order to emerge from the incubation site they must dig to the surface, an action they perform without any assistance from the adult (Frith 1959, Jones *et al.* 1995). The time taken in moving from the level of hatching to the surface varies with depth, the nature and compaction of the substrate, and energy reserves of the individual hatchlings (Jones *et al.* 1995). Observations of the chicks of the mound building Nicobar Megapode have not been published in detail. This note describes the behaviour of chicks of the Nicobar Megapode.

This study was carried out between December 1995 and May 1998 on Great Nicobar Island (6° 76'-6° 79' N, 93° 81'-93° 84' E). All the mounds in the study area were monitored. When an egg was laid, it was dug out and weighed to the nearest gram using a spring balance. After weighing and marking, the egg was reburied in the same egg chamber and the mound was re-built. To monitor the egg as well as hatchling behaviour inside the mound, glass plates were placed adjacent to the egg chambers of seven eggs. Here, 'chick' refers to both hatchlings and fledglings, and 'hatchling' refers to a chick working its way out of the egg and up to the surface. Once at the surface and out in the open, it was called a fledgling.

In 1998, a total of seven eggs were monitored. Of these, a longitudinal crack was observed in only three eggs after 65.33 (se ±1.86) days after egg-laying and approximately ten days prior to hatching. We assumed that the force within the egg might be the reason for the crack and it could be the initial part of the hatching process.

Activities of hatchling: The climb of the hatchling from the egg chamber to the surface is a long process (Jones *et al.* 1995). In our study, a chick took up to 83.8 hours (se ±12.7, n=5) to reach the mound surface, which is higher than other mound builders (Jones and Birks 1992). The mean rate of movement was about 1.25 cm per hour (se ±0.07, n=5). Movement of the hatchling was effected by two factors. The breathing of the hatchling resulted in contraction and expansion of the body, which loosened the soil, the legs were then flexed and the hatchling was pushed upwards. The average rate of leg kicks of the hatchling was 2.7 kicks /hour (se ±0.2).

Chicks invariably left the mound soon after reaching the surface. Successful hatching was indirectly indicated by the hatching holes on incubation mounds with a damp surface. In case of a mound with dry surface, the hatching hole could not be seen due to shifting of sand.

Activities of fledgling: A total of 22 chicks were sighted in the study area. Of these 17 chicks were captured and released. As soon as a chick emerged from the mound it preened its body and leg. Once, within seven seconds of emerging, a chick flew 53 m. Another hatchling, as soon as it emerged out from the mound, flew and perched on a branch 73 cm from the ground. Chicks made alarm calls when handled. Locating chicks on the forest floor was difficult, as they camouflaged with the ground. A chick was frightened even on seeing a tree shrew *Tupaia nicobarica.*

Fate of chick: All the chicks sighted in the field were on or near the incubation mounds. Although locals reported sighting chicks in the interior forest, we did not see any. Six dead chicks were seen in the study area. Of these, four hatchlings were seen being eaten by a Nicobar Serpent-Eagle *Spilornis minimus klossi*, Nicobar Sparrowhawk *Accipiter butleri* and hermit crabs *Pagurus* sp.

Of the 17 chicks captured, five had an opaque membrane over the eye that rendered the bird blind, of which we cured three by immersing them in seawater and two died. Considering how alert the chicks are, it is likely that those preyed upon were also born with the eye disorder.

At one mound, an adult bird kicked out an emerging hatchling from the mound while digging a pit. No reaction was noticed between the adult and the fledgling. The fledgling left the mound after a short rest. In another mound, a pair, while digging a pit, kicked out an embryo from the egg chamber. The embryo was not fully developed and hence died.

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14. BLACK TERN *CHLIDONIAS NIGER* (LINN.) IN MYSORE, KARNATAKA: FIRST RECORD FROM INLAND SOUTHERN INDIA

A Black Tern *Chlidonias niger* in full breeding plumage was observed at Lingambudhi lake (12° 16' N, 76° 37' E) in the outskirts of Mysore city (12° 18' N, 76° 39' E) on April 5, 2002. It was seen in a mixed flock of one Black-headed Gull *Larus ridibundus*, 11 Whiskered Terns *Chlidonias hybridus*, all in breeding plumage, one Gull-billed Tern *Gelochelidon nilotica* and four Black-bellied Terns *Sterna acuticauda*. The tern was identified by the characteristic black-and-grey plumage; head was pure black and the black colour extended to the nape, neck and belly completely, becoming progressively sooty black from neck to belly, excepting the vent, which was pure white. The bird also had no black on the underwing coverts as is characteristic of the White-winged Black Tern *Chlidonias leucopterus*, and had completely grey upperwing, underwing, back and tail, of a shade comparatively darker than the Whiskered Terns that were in flight nearby. The Black Tern was noticeably smaller and distinct from the Whiskered Terns which had black caps, red beaks and sooty black bellies. The beak of the Black Tern also differed, it was thinner, longer and somewhat blackish. Observations were made using a pair of 7x35 Naturalist Binoculars and a 15x-45x Spotting Scope.

The Black Tern was seen feeding along with the Whiskered Terns, keeping a low flight over the water and feeding by picking up fish (?) or food material from the water surface, and just below the surface. The Whiskered Terns on the other hand, while indulging in similar food capture, also repeatedly made abrupt turns in flight at the same time spreading out their tail and plunged into the water to capture fish, something that the Black Tern was never observed to do. The Black Tern was observed only on April 5 and subsequent daily visits to the site, especially to obtain photographic evidence, did not yield further sightings. It was probably a passage migrant along with the Whiskered Terns.

The Black Tern *Chlidonias niger* is a winter vagrant to the Indian subcontinent with only a few records for the entire region. Although Ali and Ripley (1987) record only one old sight record from Delhi (Alexander 1950), there have been regular records of odd birds from Pt. Calimere (Abdulali and Ambedkar 1984, Balachandran 1994, Sangha 1994, also see Balachandran 1995, Menon 1992). I too have seen one individual ringed at the BNHS bird-banding camp held in December 2001. It has also been recorded from Kaliveli tank near Pondicherry (Balachandran 1994), Pulicat lake (Mohapatra and Rao 1994, Sangha 1999) in Andhra Pradesh, India and in Sri Lanka (De Silva *et al.* 1993, Hoffmann 1996).

Although the bird observed was probably a passage migrant and could be clearly discerned in the breeding plumage, it is otherwise difficult to separate *Chlidonias* tern in the field in their non-breeding plumage, especially when a large number of terns are together, despite recent improvements in illustrated field guides (Grimmett *et al.* 1998, Kazmierczak 2000). I had an experience in which six White-winged Black Terns *Chlidonias leucopterus* were picked out from a huge flock of over 2,500 Whiskered Terns *Chlidonias hybridus*, all in flight, over the Kunthur lake (12° 07' N, 77° 02' E), a large irrigation tank near Yelandur (12° 03' N, 77° 01' E) in the Chamarajanagar district of Karnataka in September 1999 (also see notes under White-winged Black Tern in Perennou and Santharam 1990); it was extremely tedious work.

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15. ON THE INSECTIVOROUS DIET OF *COLUMBA LIVIA* GMELIN

Some years ago I was watching House Crows, Koels etc. along with Spotted Owlets (in the bright morning light) eating winged termites, emerging from the ground after a heavy shower of rain. Some Blue Rock Pigeon *Columba livia* also joined the other birds on the ground and started picking up something in their bills. I assumed that they were eating grass seeds or picking up grit. However, recently on June 30, 2002, after it had rained the previous day, I saw, from the verandah of my house, four pigeons avidly eating the winged termites that had emerged from the ground! Dead insects were picked up and swallowed directly, while those still alive were shaken with a sideways movement of the bill before being gulped down.

I have kept domestic pigeons, and have had opportunities of observing free living *Columba livia*, but never have I seen them eating insects.

August 10, 2002

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16. EASTERN CALANDRA-LARK *MELANOCORYPHA BIMACULATA* IN MYSORE, KARNATAKA: A NEW RECORD FOR SOUTHERN INDIA

Fourteen Eastern Calandra-Larks *Melanocorypha bimaculata* (Ménétriès 1832) were observed at Lingambudhi lake (12° 16' N, 76° 37' E), in the outskirts of Mysore city (12° 18' N, 76° 39' E), on January 7, 2001. Five birds were observed again at the same site on February 25, 2001. The birds were observed on the north-western end of the lake in *c.* two acres of mixed grassland close to the lake. They were identified by their larger size (*vis-à-vis* the common and widespread Greater Short-toed Lark *Calandrella brachydactyla*), robust beak, distinct white supercilium, a conspicuous black patch on the side of the chest vs. a small patch, sometimes absent in *Calandrella*, absence of a white trailing edge to the wing in flight vs. its presence in the extralimital European Calandra-Lark, *Melanocorypha calandra*, and a narrow, white terminal band to the tail. In flight, the call heard was similar to that of *Calandrella*, "*chirrup*". The birds were in company of a large flock of *c.* 450 Greater Short-toed Larks and they clearly stood out in the group; the Calandra-Larks kept a little away from the other larks in the flock, but moved along with them when they flew, or when feeding in the grasses.

The Eastern Calandra-Lark is a fairly common visitor to Baluchistan, Sind, Kashmir, Punjab, Haryana, Rajasthan and Uttar Pradesh east to about the Jumna river (Ali and Ripley 1987); also termed as "erratic" in recent times (Grimmett *et al.* 1998). Specimens collected from Kutch (Himmatsinhji 1960, Ali and Ripley 1987) appear to be the southernmost records hitherto of the species. This sighting is possibly the first from peninsular India, south of the Vindhyas.

The Greater Short-toed Lark on the other hand is a fairly common species in winter around Mysore, usually in small flocks, but occasionally in large aggregations of up to a couple of thousand birds.

July 29, 2002

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17. RECORDS OF GREY-HEADED STARLING *STURNUS MALABARICUS BLYTHII* IN MUMBAI

The Grey-headed Starling *Sturnus malabaricus malabaricus* is distributed in most parts of India except Jammu & Kashmir and Western Ghats (Ali and Ripley, COMPACT HANDBOOK, 1987). The Western Ghats hold the *Sturnus malabaricus blythii* population.

On July 18, 2001, flocks of 50-300 *S.m. blythii* were seen on trees, near Godrej Colony, east Mumbai. These flocks had a large number of juveniles, still being fed by parents. Later on September 22, 2001, a flock of 300 *S.m. blythii* were observed feeding on flowers of *Ficus religiosa, F. benghalensis, F. glomerata, Cassia* sp.; they were once disturbed by a Shikra *Accipter badius*.

About ten *S.m. malabaricus* were seen once at 0630 hrs, bathing in puddles near a mangrove creek and around five to six times at *c.* 1730 hrs, mixed with a flock of *S.m. blythii*, till sunset. 25-30 Asian Pied Starling were also seen near the creek.

Such sightings have not been reported from Mumbai earlier, although according to Ali and Ripley (1987), specimens of *S.m. blythii* from Mumbai were found in mixed flocks together with *S.m. malabaricus* in July.

July 1, 2002

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18. OCCURRENCE OF THE ASHY MINIVET *PERICROCOTUS DIVARICATUS* (RAFFLES) AT THE PARAMBIKULAM WILDLIFE SANCTUARY, KERALA

A pair of Ashy Minivets *Pericrocotus divaricatus* was observed at Anapaddy in the eastern part of the Parambikulam Wildlife Sanctuary, Kerala on December 27, 2001. Parambikulam Wildlife Sanctuary is located at the border of Kerala and Tamil Nadu, on the Annamalai hill range and covers an area of 285 sq. km with habitats ranging from dry deciduous scrub to *shola* forests. The pair, a male and a female, was seen at 1100 hrs on a *Terminalia tomentosa* tree in a mixed deciduous forest plantation also consisting of *Lagerstroemia lanceolata*, *Schleichera oleosa* and *Tectona grandis* trees along with thick undergrowth of *Lantana camara*. The minivets were present in the fringes of a large mixed hunting party of seventeen species that included Scarlet Minivet *Pericrocotus flammeus*, Small Minivet *Pericrocotus cinnamomeous*, Bronzed Drongo *Dicrurus aeneus,* Ashy Drongo *Dicrurus leucophaeus,* Indian Treepie *Dendrocitta vagabunda,* Black-naped Oriole *Oriolus chinensis,* Black-headed Oriole *Oriolus xanthornus,* Common Iora *Aegithina tiphia,* Brown-capped Pygmy Woodpecker, *Dendrocopos nanus*, Brown-headed Barbet *Megalaima zeylanica,* White-cheeked Barbet *Megalaima viridis,* Crimson-throated Barbet *Megalaima rubricapilla,* Blyth's Reed Warbler *Acrocephalus dumetorum*, Brown-breasted Flycatcher *Muscicapa muttui* and Jungle Babbler *Turdoides striatus*. Rosy Starling *Sturnus roseus* and Blue-winged Parakeet *Psittacula columboides* were also present on the tree but did not appear to be involved with the mixed flock. The Ashy Minivets were very distinctive and appeared to stay a little away from the apparent confusion of the centre. They restricted themselves to the lower reaches between 4.6-6 m, whereas the Scarlet and Small Minivets were seen higher up, at around 7.6 m. After the flock moved a little further, the Ashy Minivets moved up to the place vacated by the other minivets and orioles. Their behaviour did not differ from that of other minivets, except that they were silent.

The HANDBOOK (Ali and Ripley 1987) lists the Ashy Minivet as "An accidental winter vagrant" to the Indian subcontinent, "recorded twice: near Port Blair, Andamans, November 19, 1897 and at Karnala, near Bombay, January 31, 1965". Navarro (1965) reported the bird from the mainland for the first time, sixty-eight years after the first report from the Andamans. It has, however, been subsequently observed in various parts of India like Guindy National Park, Madras city (= Chennai) (Santharam 1988), Sriharikota Island, Nellore district, Andhra Pradesh (Santharam 1990), Periyar National Park (Robertson 1992), Himachal Pradesh (Khacher 1994), Goregaon, Bombay (= Mumbai) (Paralkar 1995), Trivandrum (Kumar 1995), Kanha National Park, Madhya Pradesh (Pittie and Poddar 2000); the records appear concentrated in western and southern India. Over the years, it has been reported regularly at the Guindy National Park. It may be, therefore, regarded as a rare, perhaps regular winter visitor to the Subcontinent in small numbers. This record of the Ashy Minivet is the third from Kerala State after Robertson (1992) and Kumar (1995).

June 5, 2002

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19. SOOTY FLYCATCHER *MUSCICAPA SIBIRICA* GMELIN AND ASHY MINIVET *PERICROCOTUS DIVARICATUS* (RAFFLES) IN BANDIPUR NATIONAL PARK, KARNATAKA, SOUTHERN INDIA

While on a bird survey of the Bandipur National Park (11° 20'-11° 40' N, 76° 20'-76° 32' E) in April 2002, two interesting species were observed — the second record of the Sooty Flycatcher *Muscicapa sibirica* from southern India and the rare winter visitor Ashy Minivet, *Pericrocotus divaricatus*.

The Sooty Flycatcher was observed in dry deciduous forest between April 18 and 20, near the Inspection Bungalow at Chammanalla in the Mulhol range of the National Park. It was the evening of April 18, at 1715 hrs, when a brown flycatcher was observed launching sorties from a dry teak (*Tectona grandis*) tree at an unusual pace, to catch insects above a recently burnt plot of forest. It was similar to the Asian Brown Flycatcher *Muscicapa dauurica*, of which four individuals were also present in the vicinity offering good comparison, but differed in the following aspects *vis-à-vis* the Asian Brown: the Sooty Flycatcher was overall a couple of shades more greyish rather than brownish, bill differed in being visibly smaller and completely black vs. longer bill with a clear pale base to the lower mandible, chest and flanks were washed dusky grey, interrupted by white patches towards the flanks vs. a light brownish wash on chest, longer primary projection with reference to the tertials, a feature clearly visible and helpful in field especially if both species are together as in this case, and a pure white belly and vent appearing in contrast with the chest. The other species of brown flycatchers in southern India, the Brown-breasted Flycatcher *Muscicapa muttui* and Rusty-tailed Flycatcher *Muscicapa ruficauda* are easily separable from the Sooty and the Asian Brown and therefore not confused under ordinary circumstances.

The Asian Brown Flycatchers were noticeably slacker than the Sooty Flycatcher, but this is probably of no consequence other than the possibility of the Sooty feeding in preparation for the migration back to its breeding grounds in the Himalayas. It was observed at the same location for the next two days.

The Sooty Flycatcher's winter quarters in India, for both races *gulmergi* and *cacabata*, are "imperfectly known (records from November to March totally lacking); presumably in the foothills below *c.* 1200 m" (Ali and Ripley 1987), " poorly known" (Grimmett *et al.* 1998). Zacharias and Gaston (1993) record it from Wynaad (11° 15'-11° 55' N, 75° 45'-76° 30' E), but the record is treated as unconfirmed by Grimmett *et al.* (1998) and Kazmierczak (2000). This record of the bird, then is the first from southern India, if accepted. The similarity with the Asian Brown Flycatcher has probably resulted in individuals of the species being overlooked, but it may also be that the bird is a vagrant and should be treated as such until the emergence of further evidence to the contrary. The Asian Browns are common breeding residents at Bandipur. A 2 km transect in Chammanalla during the same trip had nearly twenty-five pairs and eight nests.

The Ashy Minivet, a female, was seen while on transect on the Karnataka-Tamil Nadu border on April 19. The habitat was a dry deciduous-moist deciduous interface with *Tectona* and *Terminalia* as the predominant vegetation; semi-evergreen trees like *Mangifera* were present along a dry stream-bed nearby. The bird had complete ash-grey upperparts, a black tail with thin white borders, white throat and a greyish wash on the underparts. It flew in from thick forest and settled on a small *Syzigium* tree before joining a mixed hunting party of birds that included the Great Black Woodpecker *Dryocopus javensis,* Small Yellow-naped Woodpecker *Picus chlorolophus,* Scarlet Minivet *Pericrocotus flammeus,* Black-headed Oriole *Oriolus xanthornus*, Black-naped Oriole *Oriolus chinensis,* Indian Scimitar Babbler *Pomatorhinus horsfieldii,* Quaker Tit-Babbler *Alcippe poioicephala*, Velvet-fronted Nuthatch *Sitta frontalis,* Black-lored Yellow Tit *Parus xanthogenys* and Black-naped Monarch-Flycatcher, *Hypothymis azurea*. The bird kept to the middle storey in the canopy along with the oriole and fed moving along thin branches.

The Ashy Minivet is probably a rare winter visitor to the Subcontinent (Grimmett *et al.* 1998, Thejaswi and Shivaprakash 2004) rather than "accidental winter vagrant" (Ali and Ripley 1987). There have been records from Madras (now Chennai), in Tamil Nadu (regular in Guindy National Park) and Sriharikota in the Nellore district of Andhra Pradesh (Santharam 1988, 1990), Periyar National Park (Robertson 1992), Parambikulam Wildlife Sanctuary (Thejaswi and Shivaprakash 2004) and Trivandrum (Kumar 1995) in Kerala. This is the first record of the bird from Karnataka state and hence of interest.

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20. NEW SITES FOR THE GLOBALLY THREATENED YELLOW-THROATED BULBUL *PYCNONOTUS XANTHOLAEMUS* (JERDON) IN KARNATAKA, KERALA AND TAMIL NADU, SOUTHERN INDIA

The Yellow-throated Bulbul *Pycnonotus xantholaemus* is a globally threatened, "Vulnerable" species (Collar *et al.* 1994, BirdLife International 2001), locally occurring over parts of eastern and southern Karnataka, south-western Andhra Pradesh, and northern and western Tamil Nadu with stony foothills scrub as its favoured habitat (Ali and Ripley 1987, BirdLife International 2001). This rare peninsular endemic has recently been the subject of studies on status assessment and habitat preference (Subramanya *et al.* 1995). The breeding biology of the bird has been studied only recently (Venkataswamappa and Chaitra 1999) although much more needs to be known (BirdLife International 2001).

Most of the sites for the Yellow-throated Bulbul in Karnataka are located in the Bangalore Rural district (BirdLife International 2001). A limited survey conducted in 2001-2002 of selected areas with suitable habitat in Chamarajanagar, Hassan, Kodagu, Mysore and Mandya districts of southern Karnataka resulted in seven new localities for the species, including the first from the Western Ghats of Karnataka. Opportunistic bird watching has added a site each at the Chinnar Wildlife Sanctuary in Kerala and Dimbum in Tamil Nadu.

The Yellow-throated Bulbul was located at Arasanakatte State Forest, Arsikere hills (Hirekal State Forest), Bandipur National Park, Bettadapura hill, Chamundi hill, Melkote Temple Wildlife Sanctuary, Nagamangala and Bettadahalli near Somwarpet, all in Karnataka.

Arasanakatte State Forest: The Arasanakatte State Forest (12° 11' N, 76° 28' E) is a reserve forest situated some 20 km southwest of Mysore city on the Mysore-H.D. Kote road (Manandavadi road) in Mysore district. It is some 20 sq. km of dry deciduous scrub with *Capparis divaricatus*, *Cadaba fruticosa*, *Dichrostachys cinerea*, *Lantana camara* and *Pterolobium hexapetalum* as the dominant species along with *Canthium parviflorum*, *Randia dumetorum*, *Ziziphus oenoploea* and a few trees of *Acacia nilotica*, *Acacia leucophloea*, *Ficus benghalensis* and *Atalantia* sp. apart from a grove and scattered trees of the ubiquitous *Eucalyptus*.

Six Yellow-throated Bulbuls were located on an isolated rocky hillock known as Bettadabeedu, located in the western end of the forest, on June 19, 2002. The bulbuls were seen, separately, in the foothills of this hillock in dense scrub.

Arsikere Hills: The Maale Kallu Tirupati (Amaragiri) hills are located in the Hirekal State Forest, a 250 sq. km scrub forest near Arsikere (13° 30' N, 76° 15' E), in north-eastern Hassan district. They are an isolated chain of high rocky outcrops with a maximum height of 1,275 m. A thick scrub jungle covers the slopes and western foothills, but is denuded at several places. Vegetation is concentrated in relatively inaccessible and steep valleys and ravines and is primarily *Ziziphus*, *Capparis*, *Chomelia*, *Pterolobium* and *Canthium* interspersed with trees like *Morinda*, *Cochlospermum* and *Ficus*.

The Yellow-throated Bulbul was noted fairly frequently in these jungles in December 2001 and May 2002. Ten birds were seen and three heard late in the afternoon, *c.* 1630-1800 hrs on May 27, 2002.

Bandipur National Park: Several sightings in dry deciduous scrub in the northern boundaries of the Bandipur National Park (11° 20'-11° 40' N, 76° 20'-76° 32' E) — in November 1997 (two seen), June 1999 (six seen, one heard) — and in the Moyar gorge area in the western end of the park in June 2001 (seven seen, three heard) and January 2002 (two seen, four heard). The species has been recorded in the neighbouring Mudumalai Wildlife Sanctuary (Gokula and Vijayan 1997).

Bettadapura hill: The Bettadapura hill (12° 28' N, 76° 5' E), an isolated, conical and symmetrical rocky peak, is located in the Periyapatna taluka on the western end of Mysore district. Only two sightings of single birds, one each in December 2000 and 2001, in the hill precincts, with most of the foothills vegetation destroyed to a great extent. Surviving vegetation include *Ziziphus*, a few *Canthium* bushes, *Erythroxylon monogynum, Euphorbia antiquorum* and *Synedinium grantii*, the latter two bordering paths and agricultural fields in the immediate neighbourhood.

Chamundi hill: The Yellow-throated Bulbul was heard in the Chamundi hill (12° 18' N, 76° 33' E) of Mysore city in March 1992 (S. Subramanya *per* BirdLife International 2001). Regular sightings have been along a foothill road leading left from near the foot of the 1000 steps, along the steps at different points, in the so-named "Horse-shoe valley" in the eastern part of the hill, along the Uttanahalli road from the Nandi monolith and evergreen scrub around Nandi. The sightings have been in different vegetation types: the birds in the foothills and along the Uttanahalli road were seen in *Canthium-Capparis-Dichrostachys-Pterolobium-Dodonea-Erythroxylon-Lantana-Scutia* scrub with scattered trees of *Cassia siamia*, *Flacourtia montana*, *Plectronia didyma*, *Boswellia glabra*, *Cochlospermum religiosum*, *Chloroxylon swietenia*, *Morinda tinctoria*, *Azadirachta indica*, *Acacia auriculiformis*, several *Ficus* sp. and *Eucalyptus* sp. Around Nandi, individuals were seen in vegetation composed of *Acacia coccinea*, *Acacia suma*, *Atalantia* sp., *Citrus* sp., *Schefflera* sp., *Santalum album*, *Plectronia didyma*, *Wrightia tinctoria*, *Ficus* sp. and interspersed by bushes of *Stachytarpheta mutabilis* and *Cymbopogon* grass on rocky slopes. The species, though encountered on most visits to the area, is nevertheless uncommon when compared to the Red-vented, Red-whiskered and White-browed Bulbuls with an average sighting of three individuals per visit. It has been observed feeding on the berries of *Azadirachta indica*, *Scutia* sp., *Flacourtia indica*, *Lantana camara*, *Erythroxylon monogynum*, *Cocculus hirsutus*, *Pachygone ovata* and *Azima tetracantha*.

Melkote Temple Wildlife Sanctuary: The species is well-distributed over this 49.82 sq. km Sanctuary (12° 36' N, 77° 30' E), found in thick jungle around the three principal hills, Narayanadurga, Karikallgudda and Melkote betta. It was first observed in June 2000 at Karikallgudda, where two birds were seen and many more heard. Narayanadurga is the best place to observe this species and up to twenty-five individuals have been observed in an hour of birding. It has been recorded here since August 2001. The vegetation in the foothills is denuded scrub of chiefly *Dichrostachys cinerea* and *Ziziphus* sp. overrun by thickets of *Lantana camara* and interspersed with trees of *Terminalia chebula*, *Strychnos potatorum*, *Acacia* sp., *Plectronia didyma* and stunted *Ficus* trees in rocky crevices. The bulbul was also observed in the Narayanadurga valley in fairly thick deciduous forest of *Shorea roxburghii*, *Mallotus philippensis*, *Wrightia tinctoria*, *Schefflera* sp., *Gmelina arborea*, *Gardenia* sp., climbers of *Stephania* sp. and *Pachygone ovata* and a dense undergrowth of *Lantana camara* and *Securinega* sp. The vegetation at Karikallgudda is broadly similar to Narayanadurga without as many trees, but that at Melkote betta is overrun by *Lantana camara* and afforested with *Eucalyptus* sp. Birds were seen feeding on berries of *Lantana camara, Cissus quadrangularis*, *Scutia* sp., *Stephania* sp. and *Cissampelos pariera*. Isolated sightings of single birds have been in vegetation near and overhanging dry streambeds and light forest in undulating areas away from the hills.

Nagamangala: Two birds were observed at Aalathi Betta, a small hill *c.* 2 km from Nagamangala (12° 50' N, 76° 45' E) on April 3, 2002 (M. Mohan Kumar, *pers. comm.*) in *Lantana-Pterolobium-Ziziphus-Scutia* scrub.

Bettadahalli, near Somwarpet: This is the first record of the species in the Karnataka Western Ghats and incidentally the first record of the species west of 76° E. The species was observed in scrub that separated a degraded coffee estate from nearby rice-fields some 20 km northwest of Somwarpet and close to a small settlement called Bettadahalli in Kodagu (Coorg) district on March 16, 2001. Only one bird was seen in the area which is in the Western Ghats foothills and composed primarily of moist deciduous vegetation with some border scrub of Acanthaceae and Rubiaceae species.

Chinnar Wildlife Sanctuary: The Yellow-throated Bulbul was observed in dry deciduous scrub in eastern and north-eastern parts of the Chinnar Wildlife Sanctuary situated in the Idukki district of Kerala. Four birds were seen in March 1998 (B.R. Sheshagiri, *pers. comm.*), three birds each in March 2000 (A. Shivaprakash, *pers. comm.*) and April 2002 (*pers. obs.*). The species has been recorded once at Monkey falls area in the neighbouring Annamalai hills (Kannan 1992) and more frequently in Bodiyakanur, on the road to Munnar (BirdLife International 2001).

Dimbum: Eighteen birds were observed in degraded dry deciduous forest near Dimbum on June 14, 2002 and 24 birds were seen in evergreen scrub on the steep Satyamangalam Ghat downhill towards Satyamangalam on June 15, 2002. Dimbum (*c.* 1,250 m) is a settlement of a few huts located on the southern end of the Biligirirangan hills *c.* 10 km from Satyamangalam (11° 31' N, 77° 15' E) in the Periyar district of Tamil Nadu. The vegetation at Dimbum is the interface between a degraded dry deciduous forest of teak (*Tectona*), bamboo (*Dendrocalamus*) and *Lantana* thickets and evergreen scrub of *Plectronia didyma*, *Schefflera* sp., *Canthium* sp. and *Ziziphus* sp. The typical vegetation on the Satyamangalam ghat slopes can be characterised as the same evergreen scrub, but a few deciduous trees of *Ailanthus excelsa*, *Boswellia glabra*, *Chloroxylon swietenia* and other species. At the foothills, most vegetation is *Dodonea*, *Erythroxylon*, *Lantana*, *Ziziphus* etc., rapidly replaced by the mesquite, *Prosopis juliflora* away from the hills.

The bulbuls were fairly common both along and away from roadside bushes in middle elevation and higher elevation on the Ghat, at a maximum of *c.* 1,250 m around Dimbum. This is probably an altitudinal record for the species. The species has been previously documented from the northern parts of the Biligirirangan hills (Karthikeyan *et al.* 1995)

Discussion: The species appears to be common in only two of the nine sites listed here, parts of the Melkote Temple Wildlife Sanctuary and the Satyamangalam Ghat jungles, although regular surveys in the Chinnar Wildlife Sanctuary may result in more encounters.

An interesting feature of isolated populations like those of Chamundi hill, Arsikere hills, Arasanakatte State Forest, Melkote hills and Bettadapura hill is the absence of intervening hills or suitable habitat from the nearest relatively contiguous habitat in the Eastern Ghats of south-eastern Karnataka. This could suggest that the species was once more widespread than it is today and could have been found in scrub jungles away from hills. The gradual conversion of the plains jungles into agricultural lands limited most relatively undisturbed scrub forests to the hilly areas and the bulbul could have then been restricted to hill and foothills scrub. Birds observed away from hills at Melkote appear to support this premise, but more studies are required to prove it for certain.

The bird observed near Somwarpet is indicative of a relict, possibly a small population. Foothills areas with good scrub were also surveyed in the vicinity in March 2001, but did not yield any bird of the species. Moreover, with the great reduction in forest cover in the area and the subsequent replanting with coffee to the lowest slopes has forced the bird to vegetation bordering the coffee estates as in the Shevaroys (Karthikeyan 1995).

In the isolated and fragmented habitats like the Arasanakatte State Forest, Arsikere hills, Bettadapura hill, Chamundi hill and Aalathi Betta, the pressure on foothills forest is immense and rising. While land in the former three sites is being diverted for agriculture, the latter site is facing encroachments from nearby ashrams and residential localities. Forests at all sites including the scrub jungles in the northern boundaries of the Bandipur National Park face the danger of vegetation loss to fuel wood collection by residents of nearby villages. This reaches a peak in summer when the vegetation is dry, just before the breeding season of the birds that coincides with the onset of the monsoons. The Melkote Temple Wildlife Sanctuary, an important site for the species, is severely affected by a shortage of staff for effective monitoring and prevention of encroachments and vegetation loss. The bulbul survives in good numbers in the remote areas of the Park, relatively away from human habitations and disturbances.

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21. OBSERVATIONS ON THE RUSTY-RUMPED GRASSHOPPER-WARBLER *LOCUSTELLA CERTHIOLA* (PALLAS) AT MYSORE, KARNATAKA

The Rusty-rumped Grasshopper-Warbler *Locustella certhiola*, formerly known as the Pallas' Grasshopper Warbler, was observed at Lingambudhi lake (12° 16' N, 76° 37' E), in Mysore (12° 18' N, 76° 39' E), between November 1999 and March 2000. It was first noted on November 10, 1999 in a two acre plot of tall grass near the lake. The bird, an adult, was identified by the presence of a rufous rump, a greyish crown heavily striped with black, a distinctive white supercilium and dark brown tail with white-tip. Bold, black streaks on the back were restricted and did not extend to the rump which was relatively clear of marks. Throat and underparts were white and unmarked, with a rufous wash on the flanks and vent. The Streaked Grasshopper-Warbler *Locustella lanceolata* and Pale Grasshopper-Warbler *Locustella naevia* are both heavily streaked on the chest, flanks, undertail coverts and rump, and lacking the rufous rump and white-tipped tail. The former also differs in being smaller and having streaks on throat while the latter is more or less the same size, but much paler and less accentuated streaks.

Over five months of surveillance resulted in the almost daily observation of the bird in the same locality and we familiarized ourselves with its activities. The bird was not difficult to observe in the early morning between 0700 hrs, around when it would first appear, and 0830 hrs. It would move through the grasses during the rest of the day, seldom making an appearance on the top or elsewhere. It would be visible again in the evenings, but for a short period, between 1715 to 1745 hrs that advanced further with the season and daylight conditions. Although the *Locustella* warblers are known to be "great skulkers" (Ali and Ripley 1987), the bird would often rise to the top of tall grasses and keep a look-out for a few seconds before disappearing deep into the grass again. It would do this quite often, and would sometimes hunt keeping to the top of the grasses. It was twice observed to go up to *c.* 8 m on a *Casuarina* tree to feed, although this was unusual and infrequent. On the whole, the bird could be observed fairly well, once located, as it was restricted to a small area in the grassland.

Ali and Ripley (1987), on the vocalization of the species, note "In winter only an occasional "*chi-chirrr*" is uttered." But the bird was noted to have three other calls; a low "*tit, tit*" occasionally heard when feeding, a babbler-like chatter "*kat kat kat kat*" repeated in a frenzy when excited, especially once when the bird was seen chasing a Indian Great Reed-Warbler *Acrocephalus stentoreus*, and an occasional, somewhat loud "*chirr*". The second of these calls was heard towards mid-March when the bird was noticed to become somewhat territorial, chasing other large warblers and even bushchats from the grass patch.

The Rusty-rumped Grasshopper-Warbler is recorded as a locally common winter visitor (Ali and Ripley 1987). It has been recorded only once from southern India, a specimen netted at Kuttanad in the Alleppey district of Kerala in May 1963 (George and Matthew 1965). Sugathan and Varghese (1996) record it from the Thattakad Bird Sanctuary in Kerala, but see Santharam (2000). The Streaked Grasshopper-Warbler is recorded as a scarce winter visitor from parts of eastern and northern India (Ali and Ripley 1987) with a recent record from Sri Lanka (Hoffmann 1996), while the Pale Grasshopper-Warbler is a widespread winter visitor in India, especially the Western Ghats and has also been observed at the same site as the Rusty-rumped in Mysore. This observation from Mysore is the second from southern India and provides details of vocalization hitherto not recorded.

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22. A SIGHT RECORD OF TYTLER'S LEAF-WARBLER *PHYLLOSCOPUS TYTLERI* FROM THE NILGIRIS, SOUTHERN INDIA

Tytler's Leaf-Warbler *Phylloscopus tytleri* Brooks, 1872, is listed as a 'Near Threatened' species by BirdLife International (2001). The winter range of this species according to Ali and Ripley (1987) is "little known, records very scanty..." A recent update (Rasmussen 1998) includes the complete Western Ghats in general and Mahabaleshwar in the northern Western Ghats of Maharashtra in particular in the winter range of the species. It is possible that it has been infrequently recorded in the winter range due to identification difficulties (BirdLife International 2001, Rasmussen 1998). In southern India, the only records of this species are one each from Goa (Price 1980) and Londa (Koelz 1942), two old records from the Nilgiris (Ali and Ripley 1987), one each from the Palni Hills (Baker and Inglis 1930), Wynaad (Zacharias and Gaston 1993) and Munnar (Harrap and Redman 1989). The habitat preference of the species in winter has been imperfectly recorded, with a few records from the middle storey of *sholas* and broadleaved forest (Grimmett *et al.* 1998).

A Tytler's Leaf-Warbler *Phylloscopus tytleri* was observed at the *Tiashola* (*c.* 2,200 m) in the south-eastern part of the Upper Nilgiris Plateau on April 25, 2002. *Tiashola* is perhaps the largest tract of intact *shola* (Montane Wet Temperate Forest) left on the Upper Nilgiris Plateau. The bird was seen on the edge of the *shola*, at 0900 hrs in an open area beside a road, on a wattle (*Acacia dealbata*) tree at *c.* 5 m. It was engaged in feeding while perched on branches, moving horizontally along branches and then vertically up to the next. Identity of the bird was confirmed by a long, lean and dark beak, an extended whitish supercilium and dark eye-stripe, olive green upperparts tending to grey, absence of any wing-bar, white underparts washed grey and short tail. The bird also appeared very fat, like most warblers at the time of the year when they are preparing to leave for their breeding grounds. The characteristic call clinched the identification; an extended, somewhat loud, mournful '*szooeet*' repeated often, rendered by Kazmierczak (2000) as a "plaintive, drawn-out *(p)ssoooeet*". Three Tickell's Warblers, *Phylloscopus affinis* were also present on the tree.

This record of the Tytler's Leaf-Warbler, along with the recent records from elsewhere in the Western Ghats reinforces the suggestion that the species does occur in the south, but has been perhaps overlooked owing to confusion with identification. This record corroborates previous records of the bird from *shola* habitat which are probably the preferred wintering habitat in the southern Western Ghats. A special look-out should be kept for the bird in field.

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23. SIGHTING OF WALLCREEPER *TICHODROMA MURARIA* IN ASSAM AND MANIPUR

The wallcreeper *Tichodroma muraria* is a bird of higher elevations, usually preferring areas above 3,300 m in the mountains. However, in winter it may come down to the foothills, occasionally straggling into the plains. In north-eastern India, it was known only from Eastern Himalaya in Arunachal Pradesh as a winter visitor (Ali and Ripley 1987). Here I report two sightings, one each in Manipur and Assam.

While driving from Imphal in Manipur to Hailakandi in Assam, I saw a bird on a barren cliff by the side of NH 53 in Manipur at about 0845 hrs on January 20, 1996. The exact location was between Keithelambi and Tupul, about 40 km west of Imphal in Senapati district (24° 47' N, 93° 42' E), and at *c.* 1,100 m above msl. The bird soon flew off, showing its crimson wings. This was apparently the first record for Manipur.

The first record of wallcreeper in Assam was from Kaziranga National Park on December 19, 1994 (Barua and Sharma 1999). This sighting was significant and hence included in THE BIRDS OF ASSAM (Choudhury 2000). On March 25, 2001 at 0840 hrs, I saw one wallcreeper in flight on the banks of Jongrong Nullah in Mathanguri Beat area of Manas National Park (26° 42' N, 90° 59' E), at *c.* 100 m above msl. The bird flew from the woodland on the south bank to the north bank taking a north-westerly direction. Again, the crimson wings with white spots were conspicuous.

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24. PROBABLE HYBRIDISATION BETWEEN WEAVERBIRDS, *PLOCEUS PHILIPPINUS* AND *PLOCEUS MANYAR*

The frequency and outcome of hybridisation between species determines the extent to which they remain genetically distinct and can evolve independently. For this reason, records of hybridisation in the wild are of interest from the evolution and speciation point of view.

I studied the breeding behaviour of weaverbird between 1998 and 2000 at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT-Asia), Patancheru, Andhra Pradesh, India. During this time, I discovered one nesting attempt involving a possible hybridisation between a male Baya Weaver (*Ploceus philippinus*) and a female Streaked Weaver (*P. manyar*). On September 11, 1998, I observed a female Streaked Weaver perched on a Baya Weaver nest at the "helmet" stage located in a small colony of about 3 males and 5 nests on an *Acacia nilotica* tree. When I next watched the colony, on September 24, a female Streaked Weaver (presumably the same individual) entered this same nest (now with brood chamber complete), while being displayed to by a male Baya Weaver. Upon checking the contents of the nest the next day, I found three eggs (mean length and width: 21.63 x 14.97 mm). One of these eggs hatched on September 29, and I subsequently observed the female Streaked Weaver bring food into the nest. The nest was checked frequently until October 12, by when the single chick had grown substantially and was almost fully feathered. The two unhatched eggs remained in the nest. When I next returned, on October 23, I found the desiccated carcass of the chick and fragments of eggshell covered by loose strips of grass, typical of the nest having been occupied by the arboreal mouse *Vandaleuria oleracea*.

Were the eggs laid by this Streaked Weaver truly hybrid? Egg dimensions are of little use in addressing this question because the egg size is similar in both the species (Ali and Ripley 1978). However, since hybrids are often unviable, the outcome of this nesting attempt is important. The proportion of unhatched eggs (2 of 3, or 0.67) in the clutch was very high compared to that in normal Baya Weaver clutches in this population (mean proportion of unhatched eggs in Baya Weaver clutches was 0.21, *N*=91 complete clutches). In only two of 91 normal Baya Weaver clutches was this proportion 0.67 (and never higher). Ambedkar (1964) presents equivalent data for Baya Weavers (proportion unhatched 0.24, *N*=291 eggs; clutch-specific data not presented). More importantly, this proportion is similarly low for Streaked Weavers (0.27, *N*=70 eggs; Ambedkar 1972), indicating that it is indeed unusual for 2 of 3 eggs of this species to remain unhatched.

If one can accept this observation as an instance of interspecific hybridisation, can the frequency of such hybridisation be estimated? Over three seasons, I observed 270 within-species pairings in the Baya Weavers. No interspecific pairs were seen in the 118 Black-breasted Weaver (*P. benghalensis*) nests, and no Baya Weaver x Black-breasted Weaver hybrid was seen. I have no detailed information on Streaked Weaver pairs, in part, because this species was relatively uncommon. Based on the two common weavers it would thus appear that hybrid pairs are very rare in this population.

Crook (1963a) studied the behavioural factors leading to reproductive isolation between all four species of Indian weaverbirds. He observed female Baya Weavers visiting Streaked Weaver nests and cites observations of male Black-breasted Weavers chasing and mounting female Streaked Weavers (the reciprocal situation has also been observed; Ambedkar 1972), but concluded that there was no good evidence for hybridisation among Indian weavers in the wild. Two records of possible hybrids between captive male Streaked Weavers and female Baya Weavers are in the literature (Gray 1958). Records of morphological intermediates between other weaverbird species, for example between the Village Weaver (*P. cucullatus*) and Vieillot's Black Weaver (*P. nigerrimus*) in Africa (Chapin 1954, Crook 1963b), have been taken as evidence for occasional hybridisation.

What factors might influence hybridisation among birds? Not all hybrid matings are biological dead-ends. Hybrid pairings between Pied (*Ficedula hypoleuca*) and Collared (*F. albicollis*) Flycatchers in Europe produce sterile daughters, but fertile sons. Female *F. albicollis* reduce the costs of hybrid mating by producing more sons than daughters and, for reasons not completely understood, late-season females gain the highest reproductive success by mating with heterospecific males (Veen *et al.* 2001). Similarly, Nuechterlein and Buitron (1998) argue that it is adaptive for male Western Grebes (*Aechmorphus occidentalis*) to increase their response to female Clark's Grebes (*A. clarkii*) when female Western Grebes are scarce. Thus, it appears that hybridisation may actually be beneficial under certain circumstances. In ICRISAT, Streaked Weavers were uncommon during my study, with a population of about 30 males. Also, the hybrid pair was seen very late in the season, when opportunities for nesting decline. Proximity of nesting location may also influence the frequency of hybridisation, but there were no Streaked Weaver colonies within a radius of 1 km of the Baya Weaver colony in question.

More information on hybridisation among Indian birds (and other taxa) is needed. Observations on hybridisation will be particularly useful if they are presented in conjunction with information on the relative frequency and outcome of such pairings.

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25. *TOR PUTITORA* (HAMILTON, 1822) AS AN ADDITION TO THE FISH FAUNA OF PENINSULAR INDIA

Genus *Tor* (Gray 1834) shows wide distribution in the freshwaters of Asia, Africa and Indo-Australian Archipelago (Tilak and Sharma 1982). The six species of *Tor* described so far show a distinct pattern of distribution from great Himalayas to Peninsular region in the Indian subcontinent. Among the species in the genus *Tor*, *T. putitora* attains the largest size up to 274 cm (Misra 1962) and is characterised by an uninterrupted posterior fold in the lower lip and with a median fleshy lobe (mentum) (Tilak and Sharma 1982; Talwar and Jhingran 1991). Nautiyal and Lal (1982) reported a female specimen of *Tor putitora* having 137.7 cm length and a weight of 23 kg from river Nayar. *Tor khudree*, *T. mussullah* and *T. tor* are the three species hitherto known from South India (Kulkarni 1980; Kulkarni and Ogale 1979; Sen and Jayaram 1982; Menon 1999; Ajithkumar *et al.* 2000; Kurup *et al.* 2001; Shaji and Easa 2001). During the survey of NAT-ICAR project on Germplasm Inventory Evaluation and Genebanking of Freshwater Fishes of Kerala, the authors came across two specimens of *Tor putitora* having lengths of 260.07 and 162.02 (170.04 gm and 36.18 gm weight) respectively from two tributaries of Kabini river system, namely, Kalindi and Noolpuzha, thus increasing the number of mahseer species of Peninsular India to four.

Description: (Based on two specimens having 219.8 and 130.58 mm SL)

D III 9; P I 15; V I 8; A II 5

Head length 3.03 and 3.52, body depth 3.7 and 4.3 in standard length. Eyes lie on posterior half of the head and their length is contained from 5.59 and 6.6 times in head length and from 1.2 and 1.3 times in interorbital width. Dorsal and ventral profiles are equally convex. Two pairs of barbels are present, maxillary longer than rostral barbels. Predorsal scales 9. Origin of dorsal lies opposite to that of pelvics and midway between tip of snout and base of caudal fin. Dorsal spine bony, strong and smooth, equal to depth of body. Caudal fin is sharply forked. The least height of caudal peduncle is contained 1.6 times in its standard length. There are 26-27 large scales along the lateral line, 2½ rows between the lateral line and the pelvic fin and 3½ rows between the base of dorsal fin and the lateral line. Pelvic fin bears a well developed scaly appendage. Head is broadly pointed and the lips are fleshy and continuous at the corners of the mouth. Both the lips are hypertrophied in the smaller specimen.

Colouration: Dorsal side of the body is greenish black, while the ventral profile is silvery in appearance. The head is slightly yellowish white while the eyes are dark bluish. Fins are golden yellowish and paired fins are characterised by fringed red colouration. Caudal fin mottled black.

Habitat and ecology: *Tor putitora* was collected from the rapid and riffle habitat of Begur and Noolpuzha respectively. The smaller one was collected from the rapid habitat of Begur with bedrock as the dominant substratum while the larger specimen was collected from the riffle habitat of Noolpuzha with boulders as the dominant substratum. Flow velocity is comparatively high in both the habitats and the canopy cover is very good.

Distribution: It is found all along the Himalaya including Kashmir, Uttar Pradesh, Punjab, Haryana, Darjeeling District of West Bengal, Assam, Western Himalaya, Nepal, Eastern Himalaya, Afghanistan, Pakistan, Bangladesh and China (Tilak and Sharma 1982; Talwar and Jhingran 1991; Sen and Jayaram 1982). The present collection from the Kabini river system of Kerala extends the range of distribution of this species down to Peninsular India.

Remarks: Since there is no authentic report on the introduction of *Tor putitora* in peninsular India either accidentally or purposefully, the present report of *Tor putitora* from Kabini river is highly intriguing and gives rise to the question of the extension of its natural distributional range to peninsular India. It is interesting to note that more than half a dozen fish species show discontinuous distribution only in the Himalaya in the north and Peninsular mountains in the south. This peculiar pattern, which is also seen in the distribution of animals, is well explained by Dr. S.L. Hora in his Satpura Hypothesis (Hora 1953). The present record of *Tor putitora* from Kabini river is another valid evidence for strengthening the Satpura Hypothesis.

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26. FISHES OF THE GENUS *COLISA* CUVIER FROM MANIPUR AND FIRST RECORD OF *COLISA LABIOSUS* (DAY) FROM INDIA

The genus *Colisa* Cuvier belongs to the Family Belontidae and is distinguished from other genera in having the pelvic fins each reduced to a single ray and dorsal fin having 15-18 spines. Menon (1952) recorded *Colisa fasciatus* (Schneider) for the first time from Manipur and listed it in his list of species from the State. Menon (1954) recorded a female form of *C. chuna* (Hamilton-Buchanan) [now *C. sota* (Ham.-Buch.)] for the first time from Manipur. It is found abundantly in Loktak lake of the State. He also listed *C. fasciatus* in his list of species from Manipur. Day (1878) described *C. labiosus*, which was collected from Rangoon, Myanmar. Chaudhuri (1912), Hora (1921, 1936), Hora and Mukerji (1935), Menon (1952) and Menon (1954) reported the fishes of Manipur, but did not include *C. labiosus*. This paper gives diagnostic characters of the fishes of the genus *Colisa* from Manipur including that of the newly recorded *C. labiosus* (Day) from India.

Measurements and counts follow Jayaram (1999). The body proportions are expressed in percentages of standard length (SL) and head length (HL). The specimens of the three species, *C. fasciatus*, *C. sota* and *C. labiosus* are deposited in the Manipur University Museum of Fishes (MUMF).

Colisa labiosus (Day)

Trichogaster labiosus Day, 1878. Fishes of India. 374, pl. 79, fig. 4 (type-locality: Rangoon, Myanmar); Day, 1889. *Fauna Br. India, Fishes 2*: 372.

Material examined: MUMF L0019/18, 47.0-64.5 mm SL, 5.vi.2001-15.viii.2001, Mayang Imphal ponds and Iril river. I. Linthoingambi (IL)

Local name: Pheteen (Manipuri).

Diagnosis: Size small. The species can be distinguished from other species of *Colisa* in having very thick and papillated lips (Fig. 1b), and soft dorsal and anal fins produced. D. xv-xviii, 9-11; A. xv-xviii 15-18, C 15; P. iv 7-9; V. 1. Predorsal scales 8-9. Morphometric data of the specimens (Table 1) with comparison to that given by Day (1878) are given in Table 2.

Table 1: Morphometric data of *Colisa labiosus* (% of standard length except SL in mm)

Characters	Range	Mean	S.D.
Standard length	47.0-73.4	-	-
Depth of body	34.9-44.3	40.1	2.5
Head length	12.1-35.3	31.2	6.5
Maximum head width	17.4-20.5	20.1	0.9
Head width (nares)	11.3-15.0	13.0	1.1
Head depth (occiput)	25.0-30.1	27.7	2.0
Head depth (eye)	17.0-20.4	18.3	1.5
Snout length	7.4-11.2	8.8	1.1
Eye diameter	8.2-10.2	9.2	0.7
Inter-orbital space	14.2-16.7	15.4	0.8
Gape width	8.0-12.1	10.2	0.9
Inter-narial space	9.0-13.5	10.2	1.0
Pre-dorsal length	34.1-43.3	37.5	2.5
Pre-pelvic length	27.2-35.0	30.3	2.0
Pre-anal length	37.0-43.1	41.0	2.0
Dorsal fin base length	49.0-62.5	59.3	4.0
Pectoral fin length	29.3-34.4	32.0	1.3
Ventral fin length	81.5-97.4	91.0	6.2
Anal fin length	55.3-67.3	62.0	3.5
Caudal fin length	32.2-39.1	35.9	2.5
Body width (dorsal origin)	16.4-20.0	18.1	1.1
Body width (anal origin)	15.5-19.5	18.0	1.1

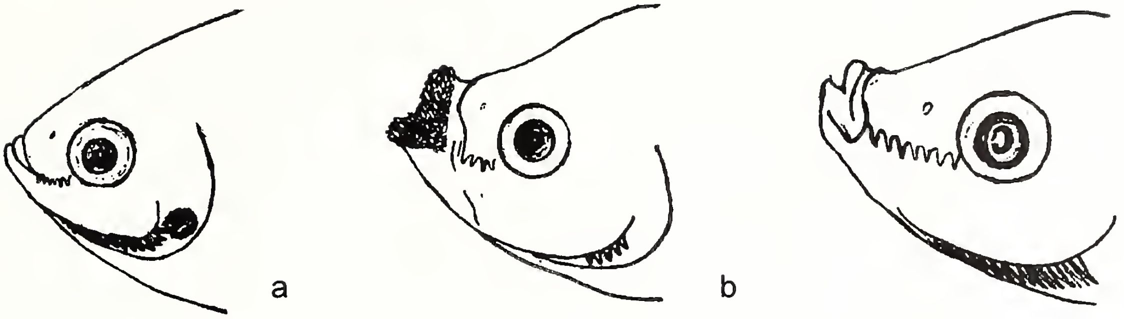

Fig. 1: Shapes of mouths in a. *Colisa fasciatus*, b. *Colisa labiosus*, c. *Colisa sota*

Colour: Greenish, lighter ventrally. Body has 8-10 oblique vertical dark bars on the sides, blue horizontal stripe on body. Fins dark, outer edge of anal fin yellowish-red.

Distribution: INDIA: Manipur: Iril river, ponds and ditches. South Myanmar.

Remarks: The body proportions of the present specimens almost fit into the descriptions of Day (1878). The fish measures 47.0-73.4 mm SL. Number of serrations on preorbital 6-11 and those on pre-opercle are short and few in number. Scales present on bases of dorsal, anal and caudal fins. Lengths of unpaired fins vary extensively in relation to head length: dorsal (144-204%), ventral (236.3-302%) and anal fin (158-206%). Iril river is a principal tributary of the Imphal river which, in turn, joins the Chindwin in Myanmar. Thus, the distribution of the species in Iril river is quite natural. This paper extends the distribution of the species to India. The fish is quiet and very graceful compared to other species of *Colisa*.

***Colisa fasciatus* (Schneider)**

Trichogaster fasciatus Schneider, 1801. Syst. Ichth.: 164, pl. 36 (type-locality: Tranquebar); Day, 1878. Fishes of India: 374, pl. 78, fig 6; Day, 1889, *Fauna Br. India, Fishes, 2*: 372, fig. 123.

Material examined: MUMF L0001/18, 46.0-65.0 mm SL, Mayang Imphal ponds and Iril river. 5.vi.2001. IL.

Local name: Ngabemma (Manipuri)

Diagnosis: D. xv-xvii, 9-14; A. xv-xvii, 14-19; C. 13; P.i-ii, 7 or 9; V.i. Predorsal scales 7-8. Body oval in shape and strongly compressed. Mouth small, slightly protrusible (Fig. 1a). There is a green spot on the distal part of the opercle. Serrations on preorbital range from 5-13, number varies from left to right. Dorsal and anal fins with a long base; the soft portion in some is rounded, in others more pointed. Anal fin ends at the origin of the caudal fin. Lateral line interrupted. Beyond the opercle it runs up to 15th scale with a gap of 2 non-perforated scales. Counting from mid-dorsal to the lateral line, the number of lateral transverse scales is 5. The second lateral line runs from 18th scale, lateral transverse scales 6. Scales present over dorsal, anal, and caudal fins.

Colour: Male with 11-13 dark bars descending obliquely downwards and backwards. Female with alternating light blue and golden yellow bands descending obliquely downwards and backwards. Anal fin with a red margin, dorsal and caudal fins spotted with orange.

Distribution: INDIA: West Bengal, Assam and Manipur. Bangladesh. Nepal. Pakistan. Upper Burma (now Myanmar).

Remarks: Morphometric data of *C. fasciatus* of the present study are given in Table 3. It inhabits rivers, lakes, ponds and ditches. It is calm and is a beautiful aquarium fish, abundant during rainy season. The size ranges from 46-65 mm SL. The number of serrations on pre-orbital ranges from 5-13, those on pre-opercle are long and many in number. Scales are present not only at the base of the anal fin, but their presence till the tip is noted. Scales present over dorsal and caudal fins as well. However, Day (1878) mentioned that scales are few on the vertical fins of Assam specimens, more on those from Kolkata or Ganjam. Talwar and Jhingran (1991) noted that the anal fin is scaly at the base only. Weber (1922) also noted presence of scales only at the base of vertical fins. The ventral fin length in percentage of head length varies extensively (235-315.5).

Table 2: Comparison of *Colisa labiosus* Cuvier with specimen from Manipur, India

Characters	*Colisa labiosus* (present study)		*Colisa labiosus* Day (1875-78)	
	In total length	In head length	In total length	In head length
Length of head	4.0	-	4.2	-
Length of caudal fin	3.8	-	3.2	-
Height of body	3.4	-	2.6-3.2	-
Eye diameter	-	3.8	-	3.5
Inter-orbital space	-	2.2	-	1.5

Table 3: Morphometric data of *Colisa fasciatus*
(% of standard length except SL in mm)

Characters	Range	Mean	S.D.
Standard length	46.0-65.0	-	-
Depth of body	37.0-44.4	41.3	2.0
Head length	30.0-35.0	32.2	2.5
Maximum head width	19.0-21.4	20.0	0.9
Head width (nares)	10.5-14.0	12.2	1.1
Head depth (occiput)	25.0-29.1	27.3	1.3
Head depth (eye)	16.0-21.0	18.0	1.5
Snout length	8.0-10.2	9.0	0.8
Eye diameter	8.0-10.3	9.5	0.6
Inter-orbital space	14.2-16.4	15.3	0.8
Gape width	5.2-9.4	10.2	2.4
Inter-narial space	9.0-13.4	10.2	2.1
Pre-dorsal length	35.1-39.1	37.4	1.1
Pre-pelvic length	26.1-31.0	29.0	1.0
Pre-anal length	21.0-45.0	40.0	5.1
Dorsal fin base length	45.3-64.0	59.0	4.1
Pectoral fin length	30.0-34.0	31.0	2.2
Ventral fin length	80.0-106.1	89.0	10.0
Anal fin length	58.0-68.0	62.1	2.2
Caudal fin length	28.0-37.0	31.4	3.2
Body width (dorsal origin)	19.0-21.0	19.4	0.8
Body width (anal origin)	17.0-20.3	19.0	0.9

Table 4: Morphometric data *Colisa sota*
(% of standard length except SL in mm)

Characters	Range	Mean	S.D.
Standard length	21.4-24.3	-	-
Depth of body	36.0-40.0	38.0	1.4
Head length	33.0-35.0	34.0	0.01
Maximum head width	18.0-19.2	19.0	0.5
Head width (nares)	11.0-13.2	10.3	4.1
Head depth (occiput)	26.0-28.0	27.0	0.7
Head depth (eye)	18.0-22.1	20.0	1.4
Snout length	10.0-12.0	10.4	0.8
Eye diameter	11.2-13.3	12.1	0.7
Inter-orbital space	14.0-16.0	14.2	2.1
Gape width	6.6-7.5	7.1	0.3
Inter-narial space	9.0-10.5	8.1	4.0
Pre-dorsal length	41.6-42.5	42.2	0.4
Pre-pelvic length	31.0-35.0	33.3	1.4
Pre-anal length	40.5-43.4	42.0	1.1
Dorsal fin base length	57.5-63.0	61.0	2.0
Pectoral fin length	25.0-30.0	28.3	2.0
Ventral fin length	64.5-77.0	71.0	4.4
Anal fin length	61.0-64.0	62.5	1.1
Caudal fin length	28.1-33.0	30.1	2.0
Body width (dorsal origin)	19.0-20.0	19.3	0.3
Body width (anal origin)	18.2-19.3	19.0	0.4

***Colisa sota* (Hamilton-Buchanan)**

Trichopodus sota Hamilton-Buchanan, 1882. *Fish. Ganges*: 120, 373 (type locality: Ganges River). *Trichopodus chuna* (Hamilton-Buchanan) Day, 1876. Fishes of India: 373, pl. 78, fig. 3; Day, 1889. *Fauna Br. India, Fishes, 2*: 371.

Material examined: MUMF L0037/6, 21.4-24.3 mm SL, Canchipur. 5.x.2001, IL.

Local name: Tombemma, Pheteen (Manipuri)

Diagnosis: D. xvii-xviii, 6-9; A. xviii-xxii, 11-13, C. 13; P. i, 9; V. i Pre-dorsal scales 7-8. Size small, body oblong and compressed, mouth small, upturned and highly protrusible (Fig. 1c). Ventral fin reaches posterior extremity of anal fin. Caudal fin slightly emarginated. Scales large.

Colour: Dull greenish, lighter along abdomen. From the eye on the side towards lower half of the base of the caudal fin, a dark, sometimes black lateral band consisting of black dots and shining with golden gloss. Caudal fin with a black spot at its base.

Distribution: INDIA: Gangetic provinces, Assam and Manipur. Bangladesh.

Remarks: Morphometric data of *C.* sota in the present study are given in Table 4. It is small and is of less importance in fishery. Length ranges from 21.4-24.3 mm SL. Number of serrations on pre-orbital 6-8 and those on pre-opercle are long and many in number.

KEY TO SPECIES

1. Body with many oblique bands from back to belly 2
— Body with a dark lateral band from eye to lower half of tail .... *C. sota*
2. Bands on body eight to ten. Lips thick, papillated .... *C. labiosus*
— Bands on body 11-13 or more. Lips thin, non-papillated .... *C. fasciatus*

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27. FIRST RECORD OF THE POLKA-DOT TRIGGERFISH *CANTHIDERMIS ROTUNDATUS* (PROCÉ) (= *CANTHIDERMIS MACULATUS*) (FAMILY BALISTIDAE) FROM MUMBAI

The monsoon season is a harbinger of unusual fishes, normally associated with coral reefs, to Mumbai. So far, the following have been recorded from Mumbai in this season: Moorish Idol *Zanclus cornutus* and Squirrel Fish *Holocentrus rubrum* (Chhapgar and Deshmukh 1964), Filamented Butterflyfish *Anisochaetodon* (*Linophora*) *auriga*, Lined Butterflyfish *Anisochaetodon* (*Oxychaetodon*) *lineolatus*, Racoon Butterflyfish *Chaetodon* (*Chaetodontops*) *lunula*, Yellow-headed Butterflyfish *Chaetodon* (*Rhabdophorus*) *xanthocephalus* (Chhapgar and Jatar 1968); Scribbled Leatherjacket *Alutera scripta* and yellow-finned leatherjacket *Monacanthus monoceros* (Chhapgar 1978), Red-toothed Triggerfish *Odonus niger*? (Chhapgar and Ringangaonkar 1990) and pig-faced filefish *Paramonacanthus choirocephalus* (Chhapgar and Muley 1997).

In July 2002, two specimens of a fish were collected at Girgaum Chowpatty (south Mumbai) and brought alive to the Taraporevala Aquarium. One died within a few days, but the larger one is still surviving at the time of writing this note. It was about 10 cm when captured, but is growing fast. It has been identified as the Polka-dot (also known as round or rough) Triggerfish *Canthidermis rotundatus* (Procé).

The body of this fish (at least at this size) does not have the typical shape of a triggerfish with a huge triangular head almost one-third the length of the body. It is more akin to Cardinal Fish (*Apogon* spp.). But it has the typical "locking-trigger" of the first (spinous) dorsal fin, and the high, triangular soft dorsal and anal fins bending together in the same direction while swimming — a movement typical of triggerfishes.

Colouration: The body is coal-black with ivory-white rounded spots scattered all over it. Within a month of capture, the number and size of these spots have perceptibly increased. The black body colouration during the day fades to a very light brown at dusk and remains so at night, darkening again in the morning. The dorsal spine is black and held erect.

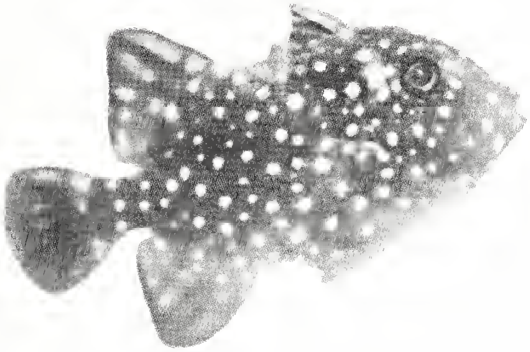

Fig. 1: Polka-dot Triggerfish, *Balistes maculatus*

The colour after preservation has been described by de Beaufort and Briggs (1962) as "light brown with dark brown interrupted longitudinal stripes on head, body and tail, dissolving into spots at bases of second dorsal, anal and caudal. Some parallel oblique stripes on cheeks." Munro (1955) also observed "undulating brown lines and fine blue spots on sides. Fins brownish. Soft dorsal with obscure blotches on middle of highest rays. Caudal dark brown" (in an 11 cm fish). Day (1878-88) gives the body colour as bluish-black. We have not observed any stripes on the live fish. It is said to grow to 55 cm. Colour illustrations of the fish have been given by Halstead (1967) in addition to the various authors mentioned in the references.

As it is not possible to make scale or fin-ray counts in the live specimen, these counts by various authors are given below.

Day: D. III/26-27, P. 15, A. 24-25, C. 12, L. l. 40-55, L. tr. 28.

Munro: D. III/25-26, A. 23-24, L. l. 42-57, L. tr. 30-54.

Barnard: D. III + 24-26, A. 24-25, L. tr. 28-30.

Smith: D. III/24-27, A. 24-26, L. tr. 30.

Beaufort & Briggs: D. III/2.23-24, A. I-2.21, P. I. 14, L. l. 42-43, L. tr. 29-34.

Jones & Kumaran: D_1 III, D_2 ii, 23-24, A. i, 21-22, P. i, 13-14, L. l. 42-44 + 6-7, L. tr. 29-32.

It is likely that the depth of the body increases as the fish grows, as seen from the illustrations given by the various authors. The depth is contained 2½ to 3 times in the total length (Day, pp. 687, 688, pl. clxxv), 1¾ times in standard length (Munro, p. 271, pl. 53), 2⅓ times (Smith, p. 409, pls. 91, 104); in small specimens, 1.7-1.9, 2-2.3 in length with caudal (de Beaufort and Briggs, pp. 309-312), 2.1 to 2.6 in standard length, 2.5 to 3.1 in total length (Jones and Kumaran 1980, pp. 665, 666, fig. 566). In our specimen it is 2.1 times in standard length 2.5 times in total length (132 mm).

Diagnostic features: A groove in front of eye. Scales rough, granular, without spines. The cheeks are entirely scaled, but there are no osseous scutes behind the gill-opening. Second dorsal and anal high anteriorly. Ventral spine short, covered with spinules, immovable (according to de Beaufort and Briggs as well as Jones and Kumaran), usually movable (according to Day). Hind edge of caudal fin convex.

The genus *Canthidermis* can be distinguished from *Xanthichthys* and *Pseudobalistes* by the nature of its cheeks, which are normally scaled and without naked grooves (*Xanthichthys* has longitudinal naked grooves, while in *Pseudobalistes* the cheeks are naked anteriorly). It differs from *Odonus* in not having red teeth. It differs from *Rhinecanthus* and *Balistapus* in having a groove before the eye. It can be distinguished from *Abalistes* in not having a depressed caudal peduncle, and from *Melichthys*, *Balistoides*, *Sufflamen* and *Hemibalistes* in not having spines on the caudal peduncle. Finally, it differs from *Balistes* in not having enlarged plates behind the gill-opening.

Systematics: There is a great deal of confusion in the nomenclature of this species. It was first described by Procé (Bull. Soc. Philom. Paris, p. 30) as *Balistes rotundatus* in 1822. The genotype is based on *Balistes angulosus* of Quoy and Gaimard 1824. (Fraser-Brunner 1935, pp. 658-663). The genus *Canthidermis* was created by Swainson in 1839, but subsequent authors, right down to Day (1878-88), continued to use *Balistes*, a genus created by Linnaeus in 1758. It was Bleeker (Atlas Ichth.des Indes Orientales Néerlandaises V, 1865) who, though continuing to use *Balistes* as genus, added *Canthidermis* as a subgenus, describing the species as *Balistes* (*Canthidermis*) *maculatus*. Jordan & Fowler (Proc. U.S. Nat. Mus. xxv, 1902) raised it to *Canthidermis rotundatus*. de Beaufort and Briggs, as late as 1962, have used the genus *Balistes* without the subgenus *Canthidermis*.

There is also difference of opinion whether *rotundatus* is the juvenile of *maculatus*, or whether the two are separate species. Most descriptions of *rotundatus* (with its synonyms *oculatus* of Gray 1832, Bleeker 1865, Gunther 1910, Duncker and Mohr 1929 and *senticosus* of Richardson 1848, Bleeker 1853 and Gunther 1910) are based on small specimens, whereas most accounts of *maculatus* (with its synonym *azureus* Lesson 1830) are of large specimens. There is further confusion as Bloch's (1786) *maculatus* is from the West Indies (Atlantic Ocean), while Bleeker's (1865) *maculatus* are from the Indo-Pacific area.

As the present specimen is of a small size, we have preferred to call it *Canthidermis rotundatus*.

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28. A GYNANDROMORPH OF *MEGACHILE* (*EUTRICHARAEA*) *GATHELA* CAMERON (INSECTA, HYMENOPTERA, MEGACHILIDAE)

Megachile (*Eutricharaea*) *gathela* Cameron is a leaf cutting solitary bee widely distributed in the plains of north India. It was collected from Himachal Pradesh, Punjab, Haryana, Eastern Rajasthan and Gujarat (Gupta 1993). Later, it was also collected from plains of Uttar Pradesh, Bihar and West Bengal by the author. It has been noted as an efficient pollinator for many cultivated and wild crops (p.o. author). *M. gathela* could be used to enhance seed yield for several cultivated crops, mainly Leguminosae and Compositae, through artificial domestication and management programmes.

Intersexes and gynandromorphs are rare. The individuals are bilaterally symmetrical and present a blending of male and female characteristics, which in addition, bear certain features common to both sexes but not found in normal specimens of either sex. Popov (1935, *Rev. Ent. USSR* p.162) figured the genitalia of a specimen of *Andrena* in which all the female structures were present in addition to the male genital structures of the right side of the body. This suggested that the entire male genital armature is phallic in origin since the appendage of the right side of the ninth abdominal segment could hardly produce both male and female structures complete.

Popov (1937, *Bull. Acad. Sci. USSR*, pp. 487-498) further described a gynandromorphic *Halictus* that suggested the same homologies between male and female genital structures. Michener (1943) reported similar intersexual homologies between male and female genitalia in genus *Ashmeadiella* Cockerell.

An interesting gynandromorph of *M. gathela*, collected during the summer of 1992, is hereby described in comparison to earlier described normal sexes (Gupta 1993; pp. 218-219 Figs. 828 to 841).

Head: Face densely pubescent (as in male), finely punctate (as in female); clypeal apical margin slightly produced, medially incurved, finely punctate; antennal sockets equidistant to each other and mid-ocellus, and close to eye margin (as in male); flagellum of antenna ten segmented, pedicel and first segment of flagellum equal in length, lateral ocelli nearer to occipital margin than to eye margin and to each other (as in female); mandible tridentate with a distinct ventral process; hypostomal spine produced (as in male); genal width lesser than eye width in lateral view (as in female).

Thorax: Characters of pronotum, scutum, scutellum, axillae, mesepisternites, metepisternites, metanotum, propodeum, wings and legs including bifurcated apices of claws resemble male.

Abdomen: Abdominal terga 1 to 6 as in male; tergal fasciae complete on apical margins of terga 1 to 4; carina of tergum 6 projecting ventrally (posteriorly in male) and slightly slanting, crenulation includes two distinct spines on left side of median emargination followed by two slightly produced tubercles, and right side of median emargination bears three obtuse tubercles making the carina asymmetrical; complete plate excluding carina margin and medio-apical emargination covered with ferruginous pubescence (as in male); apical margin of tergum 6 just below following the carina, slightly incurved at centre (as in male), however, the distance between the carina margin and apical margin is quite less (not in male); apical margin of tergum 6 constitutes the upper margin of the posterior cleft; tergum 7 not at all evident (in male apical margin of tergum 7 constitutes the upper margin of the cleft through which the genital armature protrudes out during copulation).

Sternum 1 to 3 have discal texture similar to male, apical marginal fasciae of snow white hairs quite dense and complete; density of discal pubescence gradually increases up to sternum 3, however, they remain soft, simple and comparatively elongated; discal pubescence on posterior surface of sternum 4 replaced by scopal hairs (but confined to apico-central area). Scopal bristles are found in female helping collection of pollen. Apical fasciae of sternum 4 remarkably elongated, margin broadly out-curved and with an acute median emargination (as in male); margin of sternum 5 infasciate but with dense scopal hairs confined to postgradular area of the plate (as in female). [It should be worth mentioning here that only sterna 1 to 4 are exposed in male and, sterna 5, 6 and 8 remain eclipsed under fourth sternum (sternum 7 is obsolescent in genus *Megachile*) Their apical fasciae confined to lateral out-curves of apical margins. On the contrary, sterna 1 to 6 are completely exposed and distinctly fasciate in female, a character of subgenus *Eutricharaea*.] Sternum 6 conical, apex broadly obtuse and slightly invaginated at centre, surface with dense scopal bristles, bounded with black setae, and apical margin with a fringe of black, stiff setae (as in female).

It is interesting that the genito-anal cleft in male is formed at ventral surface of abdomen in between the apical margin of exposed fourth/fifth sternum and the apical margin of seventh tergum. Here the cleft is posterio-ventral and is dorsally margined by the recurved apical margin of sixth tergum and ventrally by the apical margin of sixth sternum (intersexual character). A sting protrudes out through this cleft (as in female). Terga 1 to 6 and sterna 1 to 3 resembling male, sternum

4 that of intersex, and sterna 5-6 as in female, in addition to a projecting sting, as in female, provide a typical appearance to the bee. Externally there is no evidence of male genital armature.

Material Examined: One gynandromorph, Kangra (H.P.), June 5, 1992, Coll. S. Simlote; Flower Record: *Helianthus annus* (Sunflower) will be placed at Desert Research Station, Zoological Survey of India, Jodhpur. (Expedition financed by ICAR Scheme No. 1-3/90 PP).

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29. BUTTERFLIES ATTRACTED TO LIGHT NEAR GOVERNMENT COLLEGE CAMPUS, VATAKARA, KERALA

Many insects are known to be attracted to light. Moths are highly attracted to light. Sometimes butterflies too are attracted to light.

Usman (1956) recorded Red Pierrot *Talicada nyseus* (Lepidoptera: Lycaenidae) attracted to light at Bangalore. Shull and Nadkerny (1967) have reported five species of Family Satyridae and four species of Nymphalidae from Surat Dangs, Gujarat. Sharma and Chaturvedi (1999) recorded Black Rajah *Charaxes fabius* attracted to light at Tadoba National Park. Recently, Nair (2001) recorded Gram Blue *Euchrysops cnejus*, Tiny Grass Blue *Zizula hylax* (both Lycaenidae) and Nigger *Orsotrioena medus* (Satyrinae) attracted to light at Aralam Wildlife Sanctuary, Kerala. The present paper reports attraction of butterflies at the No: 3 /IV Staff quarters near the Government College Campus, Madappally, Kerala.

The site is situated on a small hill (50 m above msl) towards the north-west end of Kozhikode district near the Malabar Coast (11° 38' N; 75° 39' E) in Kerala and is 55 km from Kozhikode city. On the night of November 20, 2001, while collecting some insects attracted to a 60W incandescent bulb, at the verandah of the staff quarters at around 2030 hrs, I saw a butterfly flying and resting intermittently, around the light source. It was identified as the male Common Palmfly *Elymnias hypermnestra* (Linnaeus) (Nymphalidae: Satyrinae). Its movements and orientation at light was quite similar to that during diurnal hours. No dashing at light was observed.

On June 15, 2002, I saw another butterfly attracted to the light at the same site around 2130 hrs; it was raining lightly then. This time it was a male Great Eggfly *Hypolimnas bolina* (Linnaeus) (Nymphalidae: Nymphalinae). The butterfly showed movements similar to that during diurnal hours. No dashing towards the light source occurred.

Both these butterflies were unusual visitors to light. These records contradict the popular idea that butterfly activity is exclusively diurnal. More studies in this regard will reveal the secrets of this interesting phenomenon.

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30. CLADOCERAN COMPOSITION OF ADRA LAKE, WEST BENGAL

Adra lake (also known as Saheb Bund) is a relatively small water body (*c.* 2.5 sq. km), situated *c.* 5 km away from the Adra town, in the Purulia district of West Bengal (23° 42' N and 87° 01' E). The lake water is quite clean and forms the

Table 1: Systematic account of Cladoceran fauna of Adra Lake

Scientific Name	Material Examined	Description	Distribution
Family Sididae Baird 1850			
1. *Diaphanosoma excism* Sars 1885	L: 0.36, W: 0.2 mm; F	Head large, without rostrum, carapace almost oblong in outline, postero-dorsal corner of valves almost ending in right angle, eyes relatively large, with numerous crystalline lenses, located in front portion of the head, post abdomen narrow with fine setules, claw with three basal spines	West Bengal, Rajasthan and Bihar. Elsewhere in tropics and subtropics
Family Moinidae Goulden 1968			
2. *Moina brachiata* (Jurine 1820)	L: 0.36, W: 0.29 mm; F	Head depressed, supra-ocular depression not well marked. Antennules cigarette shaped, long with setae arranged in rings. Valves oblong ending bluntly posteriorly, post abdomen large, well defined and claw with large pecten of 11-14 teeth	Kashmir, Rajasthan, Meghalaya
Family Bosminidae Sars 1865			
3. *Bosmina longirostris* (O.F. Muller 1776)	L: 0.27, W: 0.17 mm; F	Body almost oval in outline; postero-dorsal corner of valves distinctly angular, postero-ventral corner produced into backwardly directed spine (mucro). Head large, slightly arched in front of the eye. Antennules almost parallel to each other, curved backward; claw with proximal pecten of 3-6 spinules	Kashmir, Meghalaya, and West Bengal. Elsewhere Cosmopolitan
Family Macrothricidae Norman & Brady 1867			
4. *Macrothrix spinosa* King 1853	L: 0.38, W: 0.21 mm; F	Carapace rounded oval in outline, dorsal margin almost evenly arched, ventral margin subangulated in middle and obliquely ascending posterior end with well marked short protuberance, head moderately large and sub-triangular, antennules enlarged at apex, ventral edge of valves separate and armed with slender spine, post abdomen short, bilobed and with a row of small anal denticles	Rajasthan, Manipur. Elsewhere-Cosmopolitan
5. *Macrothrix laticornis* (Jurine 1820)	L: 0.27, W: 0.15 mm; F	Body small, oval, with a small protruberance at its posterior end; valves with serrations on the dorsal edge distinct only in postero-dorsal edge distinct only in postero-dorsal region. Head evenly arched. Antennules broadening apically with distinct ventral articulation. Eye very near to the margin of the head; postabdomen broad with fine spines and setules	Ladakh and Nilgiri Hills
6. *Echinisca triserialis* (Brady 1886)	L: 0.3, W: 0.24 mm; F	Body roughly oval in shape; ventral margin is more arched than dorsal, with sharp protruberance in between. Serrations and bristles throughout on ventral margin but dorsum at its posterior side only. Antennule slender and cylindrical; postabdomen averagely broad, with anal spines on the both the lobes	West Bengal and Rajasthan. Elsewhere-Cosmopolitan

Table 1: Systematic account of Cladoceran fauna of Adra Lake (*contd.*)

Scientific Name	Material Examined	Description	Distribution
Family Chydoridae Stebbing 1902 **Subfamily** Chydorinae Stebbing 1902			
7. *Chydorus sphaericus* (O.F. Muller 1776)	L: 0.21, W: 0.18 mm; F	Body spherical in outline, length slightly more than height; valves with distinct postero-dorsal corner, postero-ventral corner rounded, without denticles; valves with pentagonal reticulations; rostrum pointed; post abdomen short with 7-10 anal denticles; preanal corner projection.	West Bengal, Bihar, Kashmir, Ladakh, Nilgiri hills and Meghalaya. Elsewhere-Cosmpolitan
8. *Chydorus parvus* (Daday 1898)	L: 0.12, W: 0.19 mm; F	Valves oval, corners distinct, tubercles present on the inner side of anterior margin of valves without denticles, antennules reaching apex of rostrum, antennules tapering at distal ends, post abdomen strongly projection anal denticles 9-10	West Bengal
9. *Chydorus barroisi* Richard 1894b	L: 0.32, W: 0.3 mm; F	Body elliptical; dorsal and ventral margins convex, postero-dorsal corner of valves rounded; rostrum with apical notch; antennules short and conical; post abdomen short, with 9 unequal unspines.	West Bengal and Gujarat. Elsewhere-Cosmopolitan
Subfamily Aloninae Frey 1967			
10. *Alona quadrangularis* (O.F. Muller 1776)	L: 0.28, W: 19 mm; F	Body almost rectangular with maximum height at its posterior end. Postero-dorsal and postero-ventral valves rounded; longitudinal and transverse cells of valves forming cells; head shield with pointed posterior margin; plate of labrum convex; post abdomen broadened distally, with 14-16 anal spines	West Bengal and South India
11. *Alona rectangula rectangula* Sars 1862a	L: 03, W: 0.18 mm; F	Body sub-quadrate, postero-dorsal and postero-ventral corners of valves rounded with longitudinal lines, post abdomen with 7 anal spines accompanied by setae, claw with basal spines	Ladakh, Gujarat, Rajasthan, Kashmir, Meghalaya and West Bengal
12. *Alona rectangula richardi* (Stingelin 1895)	L: 0.24, W: 0.14 mm; F	Postero-ventral corner of the valves rounded and with longitudinal lines, antennules almost reaching apex of rostrum, post abdomen slightly widening distally, with 6-9 lateral groups of setae	West Bengal
13. *Acroperus harpae* (Baird 1834)	L: 0.27, W: 0.17 mm; F	Body small, oval, strongly compressed laterally; postero-ventral corner of the valves with 2-5 denticles; antennules reaching apex of the rostrum; postabdomen slightly tapering distally, claw with basal spine	Kashmir and West Bengal

L: Length, W: Width, F: Female

main source of drinking water for the people living around. In spite of being around for *c.* 60 years, no attempt has been made to study its faunal composition, though several endeavours have been carried out in West Bengal. Cladocerans are one of the indicators for the status of water quality. As this is the only drinking water source for this railway town, the author thought that it was necessary to identify its Cladoceran fauna.

Out of the 109 species of Cladocera reported from India, 41 species were reported from West Bengal (ZSI 1991). The present study is significant, as it is the first attempt to analyse the ecosystem of Adra lake. 13 species belonging to 8 genera from five families were identified in this study (Table1).

Plankton was collected using a diving plankton net (No. 25), with a 50 ml plastic container tied at its end, from the sub-surface of this small water body during limnological studies in October, 1995 and February, 1996. Samples were preserved in 4% formaldehyde solution. Cladoceran fauna was identified with the aid of standard keys (Michael and Sharma 1988, Battish 1992).

During the study period, the cladocerans were dominant over the other zooplankton groups. They were mostly abundant and diverse during winter. Out of the 13 cladoceran species, *Diaphanosoma excism* and *Macrothrix spinosa* are most dominant, followed by *Moina brachiata* and *Bosmina longirostris*. The rest were representative.

According to Das (1989), presence of *Chydorus sphaericus*, *Simocephalus* and *Bosmina* spp. (of the lake cladoceran composition) indicates an Oligotrophic lake and *Diaphanosoma* indicates a Eutrophic lake. The cladoceran parameters in this case indicate that this water body is becoming Mesotrophic and the lake water cannot be directly used as drinking water. Some filtering units are situated in the vicinity of the system for increasing the potability of water. Concerned authorities should prevent the eutrophication of this ecosystem, resulting from anthropogenic activities in the lake environs.

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31. SOME OBSERVATIONS ON TWO RARE ENDEMIC DIPTEROCARPS OF SOUTHERN WESTERN GHATS

Dipterocarpus bourdilloni Brandis

Vernacular name: Malayalam: Karanjili, Charatanjali; Tamil: Karanjil

Distribution: *Dipterocarpus bourdilloni* is a rare endemic tree (one of the majestic dipterocarps), which usually occurs along riverbanks in the West Coast Tropical Evergreen forests up to 600 m altitude. Interestingly, this species shows comparatively narrow and staggered distribution and is mainly confined to the northern part of Kerala (Ramesh *et al.* 1996). We found some isolated patches near Mukkali (near Silent Valley, Palakkad district), Carcoorghat (Cannanore district) and Uppangal on the lower slopes of Coorg. It also occurs in Kallar valley, Damalayar, Pooyamkutty, Achankoil and Mandampatty in Kerala.

Floristics: Some of the associate species of *Dipterocarpus bourdilloni* are *Actinodaphne hirsuta*, *Antidesma* spp., *Artocarpus hirsuta*, *Bischofia javanica*, *Dipterocarpus indicus*, *Hopea parviflora*, *Hydnocarpus* spp., *Knema attenuata*, *Macaranga peltata* and *Mesua ferrea* among others. It is a large evergreen tree attaining height up to 30-40 m and girth 4-5 m, with clear straight and cylindrical bole of 20-25 m. In lowland evergreen forests of Western Ghats, it is invariably the indicator of main strata. The classification of low elevation evergreen forests of the Western Ghats is based mainly on the distribution of *Dipterocarpus bourdilloni* and *Dipterocarpus indicus* (Pascal 1988). They are often found in mixture with other trees. Buttresses are absent although the trees are large, whether this is compensated by deep rooting is not known. Branching is generally confined to the uppermost part of the trunk and appears like a flattened umbrella. Branches are orthotropic in nature. There are no side branches up to a certain height.

Bark dark brown, thick, outer bark exfoliates in irregular flakes. Leaves up to 40 cm x 20 cm, elliptic, oblong, lateral nerves about 15-75 pairs, petiole about 3 cm, long, stout, stipules larger, densely covered with stellate tomentum.

Though the tree is essentially evergreen, most of the leaves are shed during March. The new flush appears soon after the leaf fall. In the young seedlings, the initial leaves are usually opposite and much larger with many more ribs than the leaves of a mature tree. In the mature trees, leaves are smaller, erect, more leathery in texture and have less pronounced dry tips.

The stipules are most characteristic, sheathing the apical bud, often very long and persistent for a long period. The fall of the stipule leaves behind a conspicuous circular stipular scar. After the appearance of the new leaves, the fallen stipules are found on the ground in great numbers. Type of nervation can be used diagnostically, where the species has to be identified by the characters of fallen leaves rather than fruit. Racemes axillary, 4-5 flowered.

Dipterocarpus fruits, from which the family name is derived, have considerable taxonomic significance. Fruit bears nine to five winged ribs, having a stalk at the base, the two larger lobes are up to 10 cm x 1-2 cm. 3-nerved up to the middle usually the wing-like scales are of different length. The fruiting calyx is longitudinally ribbed. The fruit setting (April/May) is erratic and every year is not necessarily a good fruiting year.

Winged fruit is effectively dispersed only at high wind velocities, which are rare in tropical rain forests in most areas, but should be sufficient in the secluded habitat of the trees to induce proper dispersal over long distances. Sometimes winged fruits are distributed by water and the seedlings develop on riverbanks. The leaves often deteriorate very slowly and the seeds falling on the litter usually dry out and have little chance of survival.

Natural regeneration: During good seed years natural regeneration (immediately after the rain) of the species, up to the seedling stage is good. Thereafter, unless attended to, seedling mortality is high, probably due to excessive weed growth and overhead shade.

In normal position, the fruit lies length-wise on the forest floor, the growing radicle turns and grows upwards and only later turns down i.e. remains exposed to air for a long time, hence, the danger of drying out. Seedlings have one or more pairs of opposite leaves, followed by spirally arranged ones.

Fruit setting is generally very low. Seeds lose their viability rapidly, hence they germinate immediately after falling on the ground. After a resting period of several years, the seedlings grow continuously. During this period more saplings die, many become infested by pathogens or are consumed by herbivores, some do not survive in the deep shade and others are lost through competition. The seedlings may be shade tolerant up to the bole stage. The seedlings collected from their natural habitat and transplanted in other open areas have been successful in surviving.

Economic importance: The soft wood is used in plywood industry, building construction and match industry among others.

***Vateria macrocarpa* B.L. Gupta**

Vernacular name: Malayalam:Vellapayin

Distribution: A rare endemic species, which occurs only in a small area in Muthikulam and Attapady forests of Kerala State, as well as in the forests of Bolampatty in Tamil Nadu. It occurs mainly between 100-1,400 m.

Trees prefer rich soil having a top layer of humus with high moisture content and good drainage. In its natural habitat, the tree grows in humid climate.

Floristics: Some of the associate species of *Vateria macrocarpa* are *Aglaia* spp., *Apodytes beddomei*, *Baccaurea courtallensis*, *Cinnamomum zeylanicum*, *Cullenia exarillata* (main associate), *Elaeocarpus tuberculatus*, *Euonymus indicus*, *Glochidion* spp., *Gordonia obtusa*, *Litsaea floribunda*, *Mesua ferrea*, *Nephelium longana*, *Ostodes zeylanica*, *Pithecolobium bigeminum*, *Poeciloneuron indicum*, *Terminalia travancorensis* and *Xanthophyllum flavescens* among others.

Description: A very large elegant evergreen tree up to 40 m high and 3 m girth with clear cylindrical bole of about 15 m, without buttresses. The branches spread horizontally and form an irregular crown. No side branches can be seen till a certain height. Its bark is dull grey black, smooth with irregular white patches all over the main trunk. Bark exudes a watery sap. The old bark often peels upwards, this character often has considerable diagnostic value in field identification of the species. Leaves are up to 25 cm x 12 cm, glabrous on both surfaces, lateral nerves up to 20 pairs, parallel, prominent, leaves green yellow with age, petiole up to 6 cm long swollen at the top, minutely pubescent, stipules deciduous. Flowers in axillary panicles, white in colour. Fruits ovate narrowed towards apex, slightly curved, split apex downwards at maturity.

Fruit setting generally low, though a lot of flowers bloom. The size of the fruit also varies on the same tree. Due to their size and weight, the fruit usually falls right under the tree. With the onset of monsoon in June-July fruit ripens and start falling on the ground.

Natural regeneration: Germination starts immediately after the rain and large numbers of seedlings spring up around the mother tree and in other favourable places where seeds can reach by dispersal. Germination is epigeal. The pericarp splits longitudinally from the apex downwards. The thick fleshy reddish cotyledons emerge out after the primary root establishes itself. The seedlings are shade lovers; hence growth can be seen in the natural undisturbed forests.

The seedlings withstand a considerable amount of shade, but are very sensitive to drought, both shade and moisture is necessary for their survival.

Sometimes the fruit exhibits viviparous tendency, if good pre-monsoon showers occur. Most dipterocarps are light demanders, except in the younger stages. Sometimes the death of a tall tree creates a small patch of light sufficient only for the most competitive species to come up. The plants have red or yellow leaves, in young stages, which may signal as a deterrent to herbivores from feeding on them, giving the plant the extra competitive edge it needs for survival.

Although many seedlings may become established in the early stages, the number which survive declines rapidly over a period of time. Many become infested with pathogens or are consumed by herbivores, some will not survive the deep shade and others will be lost through competition.

No attempts have so far been made for artificial regeneration of the species.

Uses: It is used in the plywood industry, match industry and also for construction purposes.

Discussion: In India, except for *Shorea robusta*, much attention is not being given to other dipterocarps. In view of their rarity and their extreme importance in productive forestry, these two dipterocarps should be saved from the threat of extinction. All the existing trees of the two species should be given complete protection. Seedlings can be planted in gaps in the degraded evergreen forests, both outside and within the natural habitat. Seedlings can also be distributed to the people for planting.

More detailed studies on the phenology and ecology are necessary to generate information about the species, which can be used in planning out the strategy for the conservation of the two species and their habitat.

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32. ON STAMEN NUMBER AND SIZE IN *BAUHINIA PURPUREA*: A REPLY TO S. BANDYOPADHYAY

Variation in the number and size of fertile stamens in the flowers of *Bauhinia purpurea* has been reported by Bandyopadhyay (2001). Having noted this variation, we have observed 68 flowers of *B. purpurea* trees occurring in the Andhra University campus. The study indicates that the flowers show variation in both number and size of stamens. Of the total flowers observed, 48 had 3 fertile stamens, 6 had 2 fertile stamens, 8 had 3 unequal stamens (2 equal in size and one almost half the other two), and 6 had 4 unequal stamens (2 equal in size and two half the length of the filaments and ¼ the size of the anthers of the other two). The filaments of fertile stamens are 51 mm long and anthers 7 mm in size. Reddi and Rao (1993) reported that even in fertile stamens, 2.7-4% of pollen grains produced in their anthers were sterile. Considering this, the pollen grains produced in the anthers of stamens with reduced length may be largely sterile. The production of reduced and additional number of stamens in varying sizes may be a strategy developed by *B. purpurea* to enhance the probing and foraging activity of pollen collecting insects for effective pollination. Bees such *as Apis cerana indica* and *Trigona* sp. were reported to be voracious pollen collectors of *B. purpurea* by Reddi and Rao (1993). Apart from this, the variations found in *B. purpurea* are not unusual and in fact frequently found in flowering plants.

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REDDI, C.S. & C.B. RAO (1993): Pollination ecology of *Bauhinia purpurea* (Caesalpiniaceae). *J. Palynol. 29*: 115-124.

33. ON THE OCCURRENCE OF *DIMERIA CONNIVENS* HACK. IN ANDHRA PRADESH

During a floristic survey of the Eastern Ghats, we collected a grass from Y. Ramavaram, East Godavari district, which was identified as *Dimeria connivens* Hack. The species has not been mentioned in literature (Pullaiah 1997) as occurring in Andhra Pradesh, hence the present report is a new distributional record. *D. connivens* has been reported earlier from Orissa (Saxena and Brahmam 1996), Bihar (Haines 1921) and Kerala (Sreekumar and Nair 1991). The specimen has been deposited in the Herbarium of the Department of Botany, Sri Krishnadevaraya University (SKU), Anantapur. Citation, a detailed description and illustration of this species are provided here.

Dimeria connivens Hack. in DC., Monog. Phan. 6: 689.1889; Hook. f. in Fl. Brit. India 7: 104. 1896; Haines, Bot. Bihar & Orissa 1016 (1062). 1924; Mooney, Suppl. Bot. Bihar & Orissa 192. 1950; Bor, in Kew Bull. 1952: 577.1953 & Grass. Burma Ceylon India Pakistan 140. 1960.

Annual grass, culms tufted, erect or geniculate, up to 30 cm long, terete, smooth; nodes shortly and very sparsely bearded. Leaves linear or narrowly linear-lanceolate, ascending, 2.5-5.5 cm, mostly basal, apex acuminate, margins with sparse tubercled based hairs, mid-rib well marked on the lower surface; sheath slightly keeled, broadly hyaline on the margins, leaf sheath longer than the lower internodes, shorter than the upper, upper sheath close to the culm, lower one rather loose and slipping from the culms, smooth and glabrous, striate; ligule ovate, membranous, shortly ciliate, less than 1 mm long, racemes 2, erect, shortly divergent, 4.2 cm long, lower florets empty, upper florets bisexual, rachis flat, tough, 0.75 mm wide, narrowly winged, ciliate along margins; spikelets alternate, oblong or oblanceolate, greenish-yellow, 3.5-4 mm long, callus base bearded, pedicels very short, flat, lower glume 2.5 mm long, excluding the callus, chartaceous, apex acute with a sharp point, keels covered all along the beak with forwardly directed cilia; upper glume lanceolate or elliptic, 3.5 mm long, acute, winged all along the keel, wings ciliate, apical cilia 1 mm long, margin hyaline, lower lemma oblanceolate to oblong, hyaline, 1.5-2 mm long, ciliate towards apex; upper lemma linear - elliptic - acute, 2-2.5 mm long, hyaline, faintly nerved arista or awn 7 mm long; short ciliate, column dark brown, 3 mm long, stamens 2, anthers 1.5-2 mm long, bright yellow; ovary elliptic, *c.* 0.3 mm long, styles 0.5 mm, stigmas plumose, 0.6 mm long. Caryopsis linear, slightly curved.

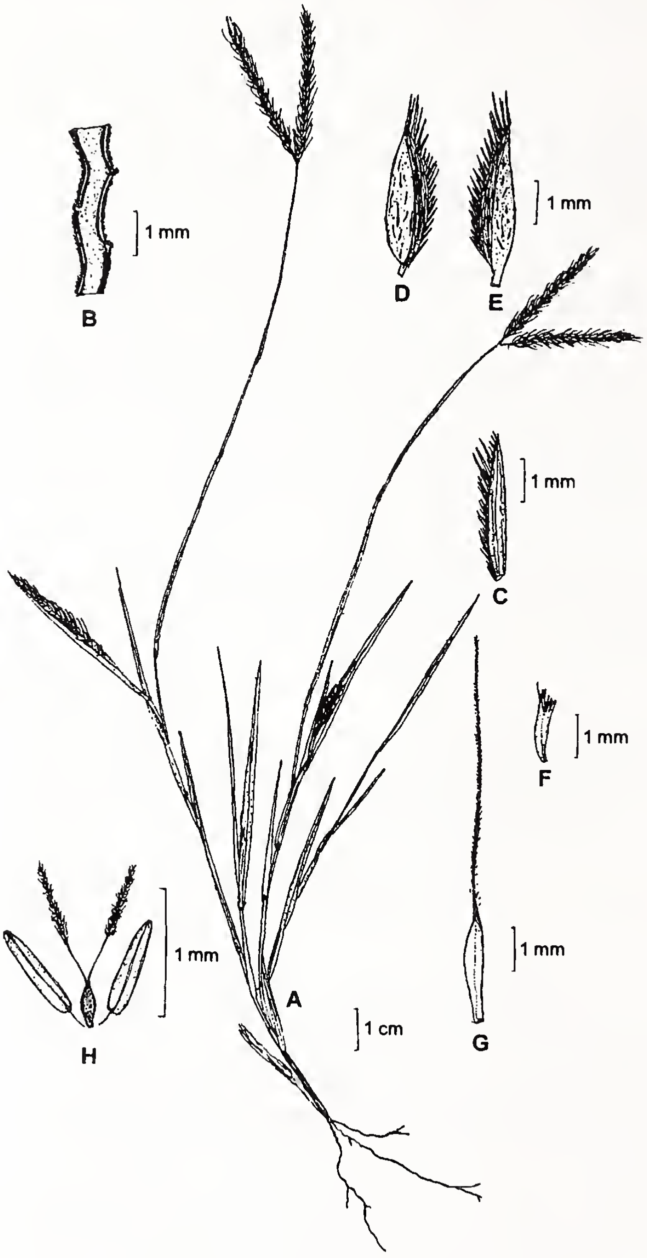

Fig. 1: *Dimeria connivens* Hack., A. Plant, B. Rachis (part), C. Lower glume, D. & E. Upper glume, F. Lower lemma, G. Upper lemma, H. Stamens and Pistil

Status: Rare in grasslands.

Fl. & Fr.: September-December.

Specimens examined: Way to Y. Ramavaram, East Godavari district, *Pullaiah* and *Gayathri* 12286.

Note: Pullaiah (1997) reports three species of *Dimeria* i.e *D. avenacea*, *D. ornithopoda* and *D. kanjirapalliana* in Andhra Pradesh. The present species differs from above in having winged, unawned upper glume.

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The authors wish to express their gratitude to the Department of Science and Technology, New Delhi for financial support. They also thank Mr. M.S. Kiran Raj, University of Calicut, for identifying the species.

June 18, 2002

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34. POIKILOHYDROUS PLANTS IN NORTHERN WESTERN GHATS

Poikilohydry is a highly specialized adaptation shown by plants growing in conditions of periodic water stress. These species are more commonly known as desiccation tolerant or resurrection plants owing to their unique adaptation for sustaining during dry periods. At the beginning of a dry spell, the tissues of these plants lose water and shrivel. However, if small amounts of water become available from rainfall or streams, these plants absorb water and resume normal growth even during the dry period.

A few such species were noted in the northern Western Ghats region where dry period is very long, almost 7-8 months. The most common and typical examples are ferns *Cheilanthes farinosa* (Forsk.) Kaulf., *Selaginella* spp., *Microsorium membranaceum* (Don) Ching and *Pleopeltis nuda* (Hook.) Ching. These species grow in habitats where water stress is severe. *Cheilanthes farinosa* grows in rock crevices or is anchored in moss on rock faces. *Selaginella* spp. are often seen in disturbed forest undergrowth. *Microsorium membranaceum* and *Pleopeltis nuda* grow as epiphytes anchored in moss on tree trunks or on boulders. Moss species and liverworts such as *Anthoceros* spp., *Riccia* spp. also exhibit this character. These plants can become fully functional even when water is provided artificially.

In angiosperms, aquatic lithophytic members of Podostemaceae e.g *Dalzellia ceylanica* (Gardn.) Wight, *Cladopus hookerianus* (Tul.) C. Cusset, *Polypleurum stylosum* (Wight) Hall and *Zeylanidium subulatum* (Gardn.) C. Cusset also show this adaptation. During the dry period, these plants appear only as greyish white marks on rocks in streambeds. With the approach of rain in June-July, the plants start photosynthetic activity, flowering and fruiting occurs during October-December. The ability of these plants to withstand extreme dry conditions and high temperatures of uncovered rocky outcrops, and resume normal functions when water is available is ecologically interesting. Gaff and Bole (1986) reported desiccation-tolerant grasses (e.g. *Tripogon*) from shallow soils in rocky areas of India. This is the first report of this peculiar adaptation in diverse plant groups like ferns and aquatic angiosperms in India. Porembski and Barthlott (2000) have discussed global distribution of desiccation-tolerant plants. They have pointed out that Madagascar and African continent, esp. east Africa, are particularly rich in desiccation-tolerant species. Phytogeographically, Indian and African flora are known to have many common elements, but so far there is no similarity in poikilohydric taxa. The most well-known poikilohydric species in east and west Africa belong to Cyperaceae, Poaceae and Scrophulariaceae. None of the Cyperaceae or Scrophulariaceae members have been described from Indian literature as poikilohydrous. It would be interesting to study these families extensively in India to search for species with similar adaptation.

Pokilohydry is a very interesting adaptation from the ecological as well as physiological view. It can have many scientific and agricultural uses in future, such as studying physiology of water uptake, establishing drought resistant crops etc. It is also of horticultural interest as these plants can withstand dry condition very well. Owing to the property of rejuvenation, *Cheilanthes* and *Selaginella* species are often sold in tourist places as curiosities, as '*sanjeevani*, rejuvenating plants'. Extensive documentation and detailed research is necessary to identify more plants in Indian floras belonging to this peculiar ecological group.

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35. FLOWERS OF SAHYADRI: A CRITICAL APPRAISAL

FLOWERS OF SAHYADRI, a handy field guide, by S.H. Ingalhalikar is easy to carry and contains data on flowers of 500 species of the Western Ghats. The map highlights the geography of the areas covered; charts with scales are given for easy reference. The appendices make the references easier, faster and comfortable.

However, flowers of many related species appear identical, and it is sometimes difficult even for an expert to name the species correctly. Some of the pictures in the book are misleading. Flowers like *Pavetta crassicaulis* (p. 56, no. 382), *Tithonia diversifolia* (p. 70, no. 465), *Kleinia grandiflora* (p. 70, no. 302), *Argyreia boseana*, *Argyreia involucrata* (p. 90, nos. 33, 36), *Argyreia sericea* (p. 87, no. 38), *Argyreia elliptica* (p. 94, no. 35), *Eriocaulon sedgwickii* (p. 126, no. 210), *Smithia bigemina* (p. 158, no. 433), *Smithia setulosa* (p. 172, no. 436), *Eriocaulon tuberiferum* (p. 140, no. 211), *Pulicaria wightiana* (p. 157, no. 404), *Sonchus oleraceus* (p. 158, no. 439), *Senecio bombayensis* (p. 172, no. 426), *Senecio edgeworthii* (p. 105, no. 427) can be mistaken for any of their allies and vice-versa. There are several misidentifications in the book which is unfortunate. Some are listed below:

1. *Physalis peruviana* (p. 134, no. 391): The photograph is that of *Nicandra physaloides*. Not only is the scientific name but its common name also is erroneous. 'Popati' is a common name used for *Physalis* species and perhaps this has been copied from the source of the misidentified species. The common name is apparently not obtained from the locality where the plant has been photographed.
2. *Avicennia marina* (p. 39, no. 46): This is probably a picture of *Avicennia officinalis*, which is mentioned as a synonym of *A. marina*. Both species are distinct and are found in marine swamps of Konkan. The vernacular name cited for this species is incorrect. 'Tiwar' is used for species of *Barringtonia* in coastal Konkan, both for *Barringtonia acutangula* ('Newar' of the author) and *B. racemosa*. Pronunciation of many local names varies tremendously. Such names have to be verified with some standard books before their application to a new species and adding to the already existing confusion.
3. The correct name for 'Nana' is perhaps *Lagerstroemia parviflora* Roxb., which is erroneously called *L. lanceolata* by T. Cooke and it is not *L. lanceolata* Wall. ex Wight & Arn. (1834), also it is not *L. microcarpa* Wight (1842). *L. microcarpa* Wight is a different species found only in South India.
4. The correct name for 'Tupa' (p. 46, no. 93) under genus *Canthium* is *Canthium umbellatum* Wt. Sometimes it is only recognised under varietal rank and Gamble identified it as a variety of *Plectronia didyma* Brandis. Brisden (in Kew Bull. 48: 762. 1993) has retained it as *Psydrax umbellata.* (Wt) Brisden.
5. *Bombax insigne* (p. 47, no. 71) or 'Deo-savar' – Both of these appear to be doubtful. It is definitely not *B. insigne* of Wallich and its local name appears to be a new one.
6. The photograph of "Kabar" (p. 49, no. 99) called *Capparis spinosa* is that of *Capparis murrayana* Graham. *Capparis spinosa* L. is a much larger leaved species found at higher altitudes in the Himalayas. The prostrate plant which is generally found on river-beds in Pune and Raigad districts is described by John Graham, a Presidency Postmaster of Bombay in his Catalogue of Bombay Plants (1839). (see "Flora of Maharashtra" by M.R. Almeida, Vol. I, pp. 46-7, t. 42, lower figure, 1996).
7. "Pinela" (p. 103, no. 468): *Trachyspermum roxburghianum* is not the correct name for the plant found wild at Sinhagad, which is photographed. It is correctly called *T. stictocarpum* (Clarke) Wolf.
8. *Capparis rotundifolia* (p. 54, no. 98) is not a typical variety, but a local variety *C. rotundifolia* Rottl. var. *longispina* (Hook. f. ex Cooke) Almeida, which was described as *C. longispina* Hook. f. & Thomson, in Flora of British India. In comparison with *C. rotundifolia* Rottl., which has rounded leaves and short spines, this variety has ovate leaves with pointed apex and long sharp spines.
9. *Ceropegia sahyadrica* (p. 119, no. 120) should be placed in the synonymy of *Ceropegia lawii* Hook.

10. *Barringtonia* species collected at Chowpatty, Bombay (= Mumbai) is definitely not *B. racemosa*. It is an introduced species, native of Bengal and has been planted along Marine Drive. Its proper identity is *Barringtonia asiatica* (Linn.) Kurz, also known as *B. speciosa* Forst & Forst. This species is found in Maharashtra only in cultivation. *Barringtonia racemosa* is an endemic wild species reported by Dalzell & Gibson and T. Cooke from Srivardhan. Some recent collectors have gathered it from Uran, Khed, Thane, Malvan and Deobag in Maharashtra.

Changes in local names, contradictory to the traditionally used ones, have to be meticulously scrutinized before adopting them.

1. Names like 'Gojibha' for *Anisomeles malabarica* (p. 50, no. 20) while the Sanskrit name 'Gojivha' represents a different species will definitely cause confusion in identification. We must go towards standardization, be it the scientific or common name of the species.
2. Local name "Koshta" for *Costus speciosus* (p. 60. no. 147) is also an improper application. This species in Marathi is called 'Pev' which is used in a Marathi proverb also 'Pev phutne'. Koshtha is a Sanskrit name for *Saussurea koshtha* (*Saussurea lappa*), a Compositae plant found in the Himalayan region much reputed for its medicinal and cosmetic properties.
3. *Withania somnifera* p. 63, no. 493: there are already half a dozen plants with the common name "Shankha-pushpi". There is a standardized name "Ashwagandha" used almost universally for this species.
4. *Ceiba pentandra* (p. 28, no. 109): Common names for this species are mentioned as "Shalmali" and "Pandhri Savar" but the correct common name is "Kapok". It is an African species, only found in cultivation and does not occur in India naturally (as mentioned in the distribution). Shalmali is a Sanskrit name for *Bombax ceiba* L. which is called 'Semul' in Hindi and "Simili" in Oriya. Similipal is in Mayurbhanj district in Orissa.
5. *Holarrhena pubescens* (p. 75, no. 265) is 'kala kuda' and not 'pandhra kuda'.

Some plant names conventionally used in our old floras have been proved incorrect. Some examples from the field guide are cited below:

1. Correct name for *Impatiens oppositifolia* (p. 159, no. 275) is *I. rosmarinifolia* Retz. Originally named *I. oppositifolia* Linn. (1753) based on van Rheede's figure in Hortus Malabaricus, the plant is identified now as *Lindernia oppositifolia* (L) Mukherjee.
2. *Ipomoea campanulata* (p. 77, no. 285) or "Tambar-vel": The correct name for this species is *Ipomoea illustris* (Clarke) Prain. *Ipomoea campanulata* L. was applied to the species presently known as *Thespesia populnea* Soland (Paras-bhendi).

Following identifications are not convincing and need a fresh look:

1. *Marsdenia tenasissima* Wt. & Arn. 'Kesdodi': The corolla is described as greenish-yellow, which is not so in the photograph. This species has been reliably reported from Dangs Forest. The plant photographed comes from Katraj and its identity needs rechecking. The description matches with Cooke's description of the species, but disagrees with his photograph in respect of the corolla and calyx.
2. *Ochna obtusata* (p. 55, no. 367) equated with *Ochna squarrosa* (Kanak-champa) reported from Castle Rock and Goa is obviously an error. *Ochna obtusata* DC. is a tall shrubby plant sometimes attaining the height of a small tree found in cultivation in gardens and very often wrongly named as *C. squarrosa* DC. Plant found in Castle Rock and Goa is *Gomphia serrata* (Gartn.) Kanis. Neither the species nor the genus can be definitely identified with only flowers as shown in the photograph.
3. *Ehretia aspera* (p. 56, no. 201) is a doubtful identification. *E. aspera* Roxb. has been reported from Marathwada with some certainty. Plants mentioned by Woodrow and Cooke from Poona district, appear to be *Ehretia laevis* Roxb. Ingalhalikar's locality scrub forests of plains, is not clear to me. If he meant coastal plains of Konkan then it could be *E. indica* (Denst. ex Kostel.) Almeida & Almeida. The identity can be confirmed only from the leaf.
4. *Rivea laotica* (p. 59, no. 412) is *Rivea ornata* (Roxb.) Choisy. A species from Laos, which is confused with *R. ornata* and has been renamed as *R. laotica* by Ooststroom (1957). Babu in FLORA OF DEHRA DUN (1957) has confused the nomenclature of our Indian plant with that species and V.N. Naik (1998) has followed Babu.
5. *Bombyx micranthus* (p. 114, no. 72) 'Pandhari-Jasvand': This generic segregation is not recognised by any good taxonomic work. Even *Bombycidendron* Zollinger & Moritze (Blumea 14:53, 1966) is not recognised as a genus and has been treated as synonymous with *Hibiscus* Linn.
6. *Crotalaria hebecarpa* (p. 171, no. 153) is certainly not a *Crotalaria* L. The name accepted here is based on a later synonym of *Hallia hirta* Willd. The current name for this is *Goniogyna hirta* (Willd.) Ali. (See Almeida, in Flora of Maharashtra, Vol. II, pp. 83-4, 1988).

7. *Kleinia grandiflora* (DC.) Rani is a species of restricted distribution in Maharashtra. The only specimens available are from Purandhar, leaves of which are rounded at the tip in addition to the absence of inflated pappus specified by Dalzell and Gibson while describing a new species from Katraj and other areas in Poona district, with inflated pappus. In addition to Dalzell & Gibson's characters I have found that leaves in this taxon are obtuse at the apex, not visible in the picture in the book.
8. *Boerhavia fruticosa* Dalz. & Gibs. The photograph is perhaps of *B. chinensis*. Proper locality of this plant is not mentioned. Some recent authors have equated *B. fruticosa* with *B. grandiflora* A. Ricb., an Abyssynian species.
9. *Cyathocline purpurea* (Don) Kuntze pictured has pinkish red heads. *C. purpurea* is reported to have purple flowers and two varieties of this species have been published by Rev. Fr. H. Santapau: *alba* (with white heads) and *bicolor* (flowers purple and white mixed). S.R. Yadav has reported a new record of *Cyathocline* from Maharashtra, a species published from Calicut by Prof. Sivadasan and others. I doubt if that is the plant photographed. I saw the report of this taxon only after publication of the 3rd volume of 'Flora Maharashtra' by M.R. Almeida (see Vol. IIIa, p. 94-5, 2001).

Some examples of wrongly synonymised cited names are given below:

1. *Exacum petiolare* Griseb. (p. 103, no. 219) and *E. pedunculatum* L. are two distinct species. The correct name for *E. petiolare* Griseb. (1845) is *E. carinatum* Roxb. (1820). The two species can be distinguished only on the basis of their leaves and number of veins arising from the base of the leaves.
2. *Haplanthus plumosa* (p. 104, no. 254) 'Kesal-jakara': If you consider *Haplanthodes plumosa* as distinct at species level, then *H. tentaculatus* is not synonymous with it. *H. plumosa* does not have hard spines as in *H. tentaculatus*. But *H. tentaculatus* has priority and modern taxonomists consider *H. plumosa* as a variety of *H. tentaculatus*.
3. *Caralluma adscendens* (p. 120, no. 101) is not the correct name for the plant photographed. *C. adscendens* Haworth is a taxon related to *Caralluma fimbriata* Wall. Graham in Catalogue of Bombay Plants named it *C. fimbriata* Wall., but later authors accept it on varietal level and call it *C. adscendens* Haw. var. *fimbriata* (Wall.) Gravely & Mayurnathan.
4. The correct name for the plant named *Exacum tetragonum* (p. 153, no. 221) is *E. bicolor* Roxb. This species from Western Ghats was misidentified as *E. tetragonum* by Graham. *E. tetragonum* is a separate species not found in Konkan region, but present in other parts of Maharashtra like Vidarbha.
5. E- 6. *Murraya paniculata* L. and *M. exotica* L. are distinct taxa at least on varietal level. *M. exotica* L. is called 'Kamini' under cultivation. It has glazed polished foliage and more fragrant flowers and somewhat blunt fruit at the apex. Its fragrance is believed to have aphrodisiac properties, particularly for women.

Rule of priority in taxonomic nomenclature governs the legitimacy of the correct names. The following are a few examples where this rule should be applied:

1. *Centaurium meyeri* (p. 106, no. 111) 'Luntak' – Correct name *C. centauroides* (Roxb.) Rao & Hemadri.
2. *Osbeckia muralis* Naud. (1850) (p. 148, no. 371) Correct name *O. truncata* D. Don (1834).
3. *Polygonum auriculatum* Meissn. (p. 162, no. 399) is now correctly called *Persicaria chinensis* (L) Gross., which is based on *Polygonum chinensis* Linn., although some taxonomists consider it as a variety of Linnean species and not the typical variety.
4. Correct name for *Hygrophila auriculata* (p. 168, no. 268) is *Hygrophila schulli* (Buch.-Ham) Almeida & Almeida.
5. Correct name for *Lavandula lawii* Wight (1849) (p. 168, no. 310) is *L. gibsonii* Graham (1839).
6. Correct names for *Paracaryopsis coelestinum* (p. 169, no. 379) and *P. malabaricum* (P. 154, no. 380) are *Adelocaryum coelestinum* (Lindl.) Brandis and *A. malabaricum* (Clarke) Brandis respectively.
7. *Crotalaria retusa* is found at sea level and has retuse leaf apex. The species found at little higher elevation and also at Mahabaleshwar, Amboli, Matheran, is a bushy shrub having acute or mucronate apices, named *C. leschenaultii*.

Ingalhalikar's terminology for the distribution of species is very often confusing, for example:

a. Occasional in deciduous forests in hilly areas of slopes. (Occasional in deciduous forests on slopes of hills?)
b. Occasional in dry deciduous forests of plains (Occasional on the plains in dry deciduous forests?)

Distribution of some of the species is based on limited field experience and could be misleading. One example should suffice:

Santalum album (p.43, no. 419) – Habitat is given as dry deciduous forests in plains. This is not an endemic species in Sahyadris. It is planted and occurs under cultivation in plains as well as in mountainous terrains.

The spelling of plant names needs correction, such as:

p. 17. *Moulluva* - *Moullava*
p. 17. *Neaotis* - *Neanotis*
p. 18. *Wadelia* - *Wedelia*
p. 34. *Albizzia lebbek* - *Albizia lebbeck*
p. 50. *Boerhaavia* - *Boerhavia*
p. 51. *Dendropthoe* - *Dendrophthoe*
p. 75. *gigantia* - *gigantea*

Flowering periods represented in colour can be true only to the limited localities that he has mentioned. They are far from the general flowering patterns of many of the species given.

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ERRATA
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pg. 225, Table 2, Column 2 **for** Total (mg/g) **read** Total Phenol (mg/g)
pg. 247, Photocredits, **for** T. Tulsi **read** T. Tsujii

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Results: Only data relevant to the objectives of the study and main conclusions emerging from the study should be included. The data should be arranged in a unified and coherent sequence for clarity and readability. The same data should not be presented in both tables and figures, and such data as can be easily and briefly stated in the text should not be depicted diagrammatically. Only such tables and figures as are necessary should be given.

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Illustrations: The number of illustrations should be kept to the minimum and numbered consecutively in Arabic numerals. Simple linear plots or linear double reciprocal plots that can be easily described in the text should be avoided. Extension of graphs beyond the last experimental point is permissible only while extrapolating data.

Line drawings should be either laser prints of computer generated illustrations or manually prepared in Indian ink on tracing paper, and should be drawn to approximately twice the printed size. The drawings are usually reduced to the page width or column size, and **care should be taken that the size of letters, numerals, dots and symbols is relatively uniform and sufficiently large to permit this reduction.**

Photographs: Photographs for reproduction must be clear, with good contrast. Prints should be at least 9x12 cm and on glossy, glazed paper.

Tables: Each table should have an explanatory title and should be numbered in Arabic numerals. Units (metric) of measurement should be abbreviated and placed below the headings. Negative results should be indicated as Nil (0) and absence of a datum by a dash.

Acknowledgements: Acknowledgements should be as brief and relevant as possible.

References: Responsibility for the accuracy of bibliographic references rests with the author. Abstracts of Papers presented at scientific meetings may be cited.

Species' names should carry the Author's name and subspecies (trinomials) should only be used where identification has been authentically established by comparison of specimens actually collected.

For the standardised common and scientific names of the birds of the Indian subcontinent refer to *Buceros* Vol. 6, No. 1 (2001).

Miscellaneous Notes: The section accommodates incidental observations on flora and fauna of the Asian region, and need not follow strictly the above section headings. No abstract is required, but key words may be included and references must be cited as in the rest of the *Journal*.

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